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Determination of axial length, radius of curvature and lens size in the developing cat eye

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DETERMINATION OF AXIAL LENGTH, RADIUS OF CURVATURE AND LENS SIZE IN THE DEVELOPING CAT EYE

A Thesis

Presented to

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by

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APPROVED

Thesis Committee

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________________ Advisor

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SECTION 1

INTRODUCTION

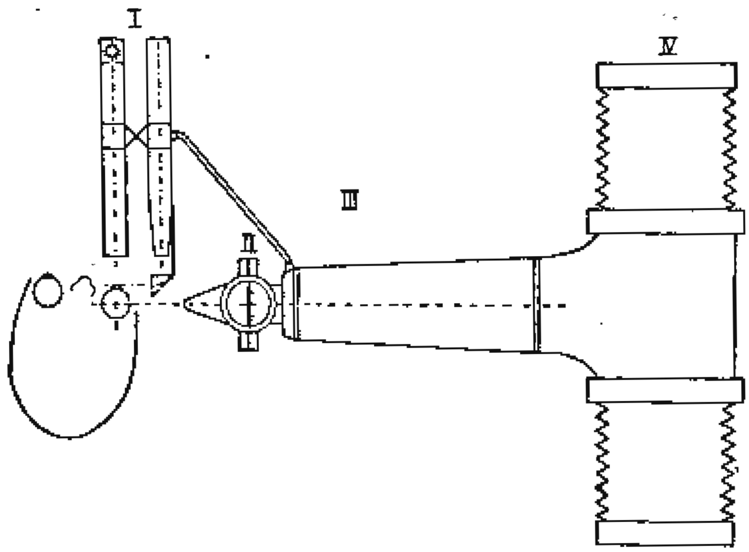
Many studies have attempted to relate corneal radius of curvature with axial length in the developing eye. Solve Stenstrom (1944) correlated data describing the optical elements of the human eye. [1] He found that due to its ease of accessability the corneal curvature was the one element of the eye subjected to the most comprehensive study, however he suggested no method existed for accurate measurement of axial length. He noted that most investigators obtained a value for the axial length by computation from the optical system, usually employing a schematic value for the power of the lens, with the result that no accurate picture of the variation of axial length could be given. Stombers (1936) and Gullstrand (1909) both employed this type of procedure in their early investigations.[2]

Czellitzer (1927) stated that the previous computation of the axial length on an eye from the refracting power, with both chamber and the power of the lens held constant, was insufficiently exact to compare its variation with that of refractive power. It was Rushton, who in 1938, published his method of measuring the axial length roetgenologically.

Rushton's method involves the fact that x-rays bring about the sensation of light in the dark adapted eye. The principle of the method is to direct a pencil of x-rays into the eye in a perpendicular plane to the optical axis. X-rays cause an excitation of the dark adapted retina at their circular intersection of the globe so that a dimly luminous ring is perceived. As the x-rays are moved posteriorly on the globe, the perceived ring shrinks to a luminous point which occurs when the pencil reaches the posterior pole. By measuring the distance from the level of the x-rays to the summit of the cornea the length of the eyeball was determined.[3] (figure 1, page 3)

FIGURE 1

Rushton's Reontgenologic Method



Schematic drawing of the apparatus used in roentgenologic measurement of the length of the optic axis. I. Fixation lamp and instrument for reading the position of the top of the cornea optically. II. Scale for recording the position of the slit. III. Diaphragm with movable slit. IV. Roentgen tube.

In 1940 G.J. Schoute published a method for measuring the length of the living eye be means of chromatic aberration.[4] In this method the length of the optic axis was stated to be in direct proportion to the apparent distance between two differently colored objects in alignment with a prolongation of the axis, however, the method did not prove to be reliable.

None of the previous methods of measuring intraocular distance afforded a possibility of making concurrent determinations of the depth of the anterior chamber, thickness of the lens and length of the optic axis. These distances, however, can be measured at the same examination by utilizing the reflection of ultrasound at the boundary between media with different acoustical properties. The phenomenon of ultrasound was developed from what has been called the "piezoelectric effect".

In 1880, the Curie Brothers found that if a quartz crystal with appropriate form, was subjected to pressure or stretching, electric charges were generated on its surface.[5] This was termed the "piezoelectric effect". A year later the brothers described the "Inverse Piezoelectric effect". This stated that if a piezoelectric crystal was placed in an electric AC field, vibrations were excited which were the same frequency as the natural mechanical frequency of the crystal, resonance occured, and the amplitude of the vibrations were rapidly increased. These resonances could be transmitted to adjacent media traversed. Using this characteristic, the first so-called ultrasound generator was constructed by Langevin in 1917.[6]

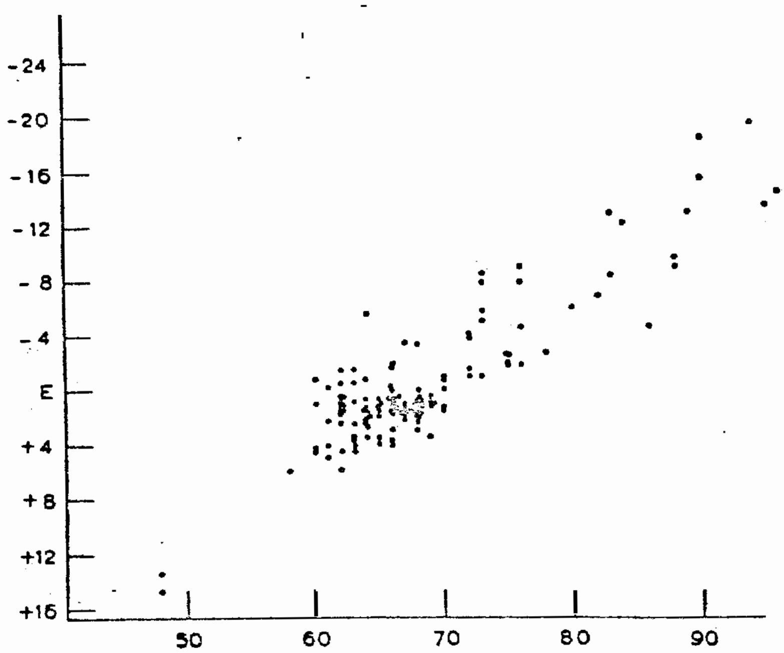
Ultrasound consists of sound waves with frequencies above the detection of human ears, in the range of 18 - 20,000 cycles per second (c/s).[7] Ultrasound of high frequency is refracted and reflected at the boundaries between different media according to physical laws. Further research made ultrasound available for medical and biological studies. Ultrasound therapy in disease conditions started in the 1930's, chiefly in Germany, Switzerland and France. Zeiss in 1938 was the first to experiment with ultrasound in ophthalmology. He investigated the effect of ultrasound on the ocular tissue, work which was followed by other experiementers: Kawamoto (1947); Lavind (1952); Donn (1955); Moore, Herrick and Martens (1955).[8]

Mundi and Hughes (1956) found that ultrasound was reflected at the boundary between the ocular media having different accoustical impedances.[9] Using pulsed ultrasound, which greatly reduced the mean intensity, these authors suggested that it was possible to measure intraocular distances with an accuracy of 1 - 2 mm.

Yamamoto (1961 determined the length of the optic axis by ultrasound using intensity of 5 - 6 w/cm^2 and a frequency of 5_{MH2}. He used a transducer having a diameter of 5mm, with a fixation light in its center, which enabled the ultrasound beam to be directed towards the fovea centralis. In computing the axial length in 23 cases of emmetropia, he found it ranged from 21.1 to 25.0 mm, and in 63 cases of myopia of varying degree from 21.5 to just over 30 mm.[10]

Franken (1961) also measured the optic axis and correlated it with the refraction of the eye. There was a wide scattering of refractions and a distinct correlation was found between refraction and length of axis. Franken's results are shown in figure 2.[11]

FIGURE 2



Correlation between length of optic axis and refraction (Franken 1961). On x-axis length of optic axis expressed in scale divisions; 50 = 16.7 mm, 60 = 20.0 mm, 70 = 23.3 mm, 80 = 26.7 mm, 90 = 30.0 mm . On y-axis the refraction.

He used a pulsating ultrasound with a frequency of 4 MH_2 and a transducer of 5 mm in the diameter. Reflecting echoes from the lens surfaces and posterior wall of the globe were recorded on an oscillograph equiped with a scale. Errors by this method were calculated to be 3% of the distance measured.

Folke Jansson in 1963 published a work comparing the axis length in the human eye determined by roetgenologically and by ultrasound. His results are shown in Table I.[12]

TABLE I

Comparison of Ultrasound to Roentgenology

METHOD	MEAN VALUE	ERROR OF METHOD
Ultrasound	23.43 ± 0.168 mm	± 0.038 mm
Reontgenologic	23.30 ± 0.158 mm	± 0.15 mm

The results obtained by these two methods were shown to be in close agreement, however the ultrasound method had great advantages over Rushton's roentgenologic one. Examination was rapidly done; dark-adaptation was unnecessary; data on depth of anterior chamber, thickness of lens, and axial length were all obtainable at the same time. Jansson also suggested that the measurements were replicable. Since the effects of ultrasound, in contrast, to roentgenologic radiation were not cumulative he established that the method was accurate and a technique of choice for clinical and experimental purposes.

As ultrasound became more widely used in the research field the term ultrasonography or USG was applied to the technique. Since a verbal response was not required as in Rushton's method, experimentally reared laboratory animals became the primary subjects for further research with ultrasound. Developmental studies of intraocular length and its correlation with the optics of the developing eye could now be attempted.

In 1962 Young and Farrer started out on a longitudinal study of the development of refractive characteristics of chimpanzies' eyes as affected by age and environmental conditions. In 1965, Young and Farrer teamed with George A Leary to continue their ultrasound and phakometry study on the primate eye.[13] The reported methods and techniques used to obtain measures of radius and power of the cornea, depth of anterior chamber, radius and power of the lens surfaces, thickness of the lens, total power of the eye, and axial length. They concluded that either ultrasound or photographic ophthalmophakometry may be used successfully on primates, but that ultrasound was the method of choice since it did not require as much time. Further they stated that USG did not require the rigid degree of control over the animal's behavior that phakometry demanded.

Vakkur, Bishop and Kozak (1962) studied the visual optics of the cat. Since the cat is one of the principal animals used in experimental visual neursphysiology and neuro-ophthalmology it is surprising that basic cat visual optics has been so little studied. These experimenters attempted to establish schematic values for the optical elements of the cat's eye.

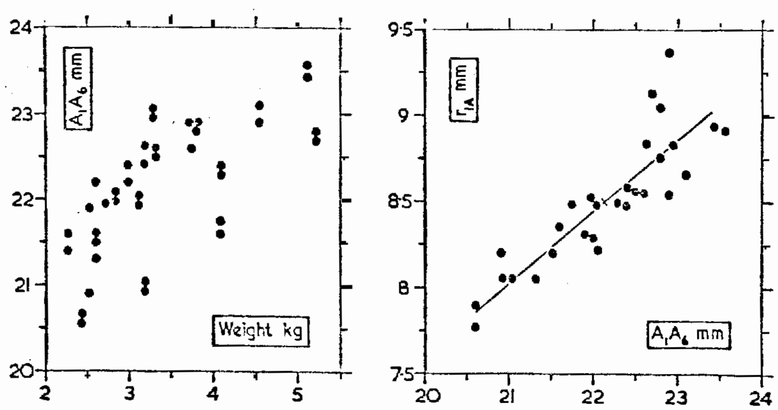
Some of the results of their experiment are shown in Table II.[14]

TABLE II

Average weight of cats	3.49Kg
Average length of eyeballs	22.31mm
Average corneal height	21.7
Average diameter of corneo-scleral junction	16.8mm
Average radius of curvature (anterior)	8.57mm
Mean corneal power	39.78D

The length of the eyeball was measured with a micrometer after injecting the excised eye with saline to 30cm water pressure. The radius of curvature of the anterior corneal surface was measured by curve fitting a pair of dividers on photographs enlarged approximately eight times. This method was stated to have an accuracy of better than 0.1mm. They found that the corneal radius in the cat is highly correlated with the length of the eyeball. These measures were in good agreement with measurements of corneal radius obtained with the keratometer. Further, results of the study also found a weak positive correlation with the cat's body weight and the length of the eyeball. (figure 3)[15]

FIGURE 3



(A). The two parameters, weight of cat and length of the eyeball (A_1A_6) are only weakly correlated. The two eyes of the same cat are, however, approximately the same length, and this results in the formation of vertical pairs in the graph.

(B). Correlation between length of eyeball (A_1A_6) and the radius of curvature of the anterior surface of the cornea (r_{1A}). The regression line for this relationship is shown, the small cross-bar on the regression line indicating the average values for all cats shown.

They defined the visual axis for the cat as that line passing through the centre of the area centralis of the retina and the centre of the entrance pupil.

In a second paper, Vakkur and Bishop (1963) in a pioneer effort postulated a schematic eye for the cat which suggests optical standards for the cat eye.[16]

A list of optical schematics for the cat established by this study is shown in Table III and Figure 4 & 5.[17]

TABLE III

TABLE 3. THE SCHEMATIC EYE OF THE CAT

Surface	(i) Position (mm)		(ii) Radius (mm)		Refractive index		
Anterior corneal	A_1	0·00	r_{1A}	8·57	Cornea	n_1	1·376
Posterior corneal	A_2	0·68	r_{1P}	7·89	Aqueous and vitreous	n_2	1·336
Anterior lenticular	A_3	5·20	r_{2A}	7·20	Lens (total)	n_3	1·5544
Posterior lenticular	A_4	13·70	r_{2P}	−8·05			
Receptor	A_5	21·83	—	—			
Posterior scleral	A_6	22·30	r_{3P}	−12·50			

		Cornea		Lens		Whole eye	
Powers (D)	Anterior surface power	F_{1A}	43·874	F_{2A}	30·333	—	—
	Posterior surface power	F_{1P}	−5·070	F_{2P}	27·130	—	—
	Total power	F_1	38·914	F_2	52·964	F_0	77·983
Distances (mm)	Anterior focal length	f_1	−25·698	f_2	−25·225	f	−12·823
	Posterior focal length	f_1'	34·332	f_2'	25·225	f'	17·132
	(see below)*	e_1	−0·064	e_2	3·742	e	4·579
	(see below)*	e_1'	−0·744	e_2'	−4·184	e'	−4·494
Positions (mm from A_1)	Anterior principal point	P_1	−0·064	P_2	8·942	P	4·514
	Posterior principal point	P_1'	−0·064	P_2'	9·516	P'	5·022
	Anterior focal point	—	−25·762	—	−16·283	F	−8·309
	Posterior focal point	—	34·268	—	34·741	F'	22·153
	Anterior nodal point	N_1	8·570	—	8·942	N	8·823
	Posterior nodal point	N_1'	8·570	—	9·516	N'	9·330

Out-of-focus distance	A_5F'	+0·323
Posterior nodal distance	PND	12·500
Refractive state	K	+1·500

* In a combination of two optical systems e refers to the distance from the posterior principal plane of the anterior element to the anterior principal plane of the combined system, and e' refers to the distance from the anterior principal plane of posterior element to the posterior principal plane of the combined system.

FIGURE 4

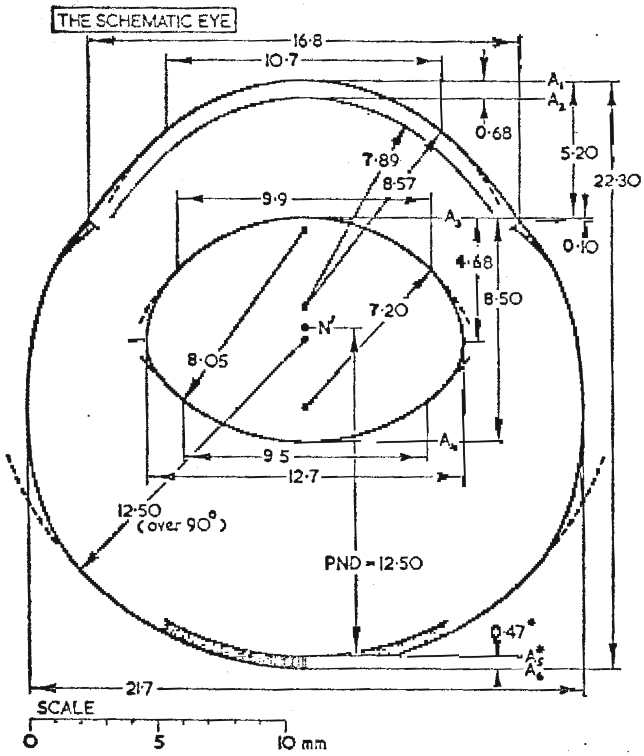


FIG. 4. The schematic eye: physical dimensions. A scale drawing of the eye forming a companion to Fig. 5.

FIGURE 5

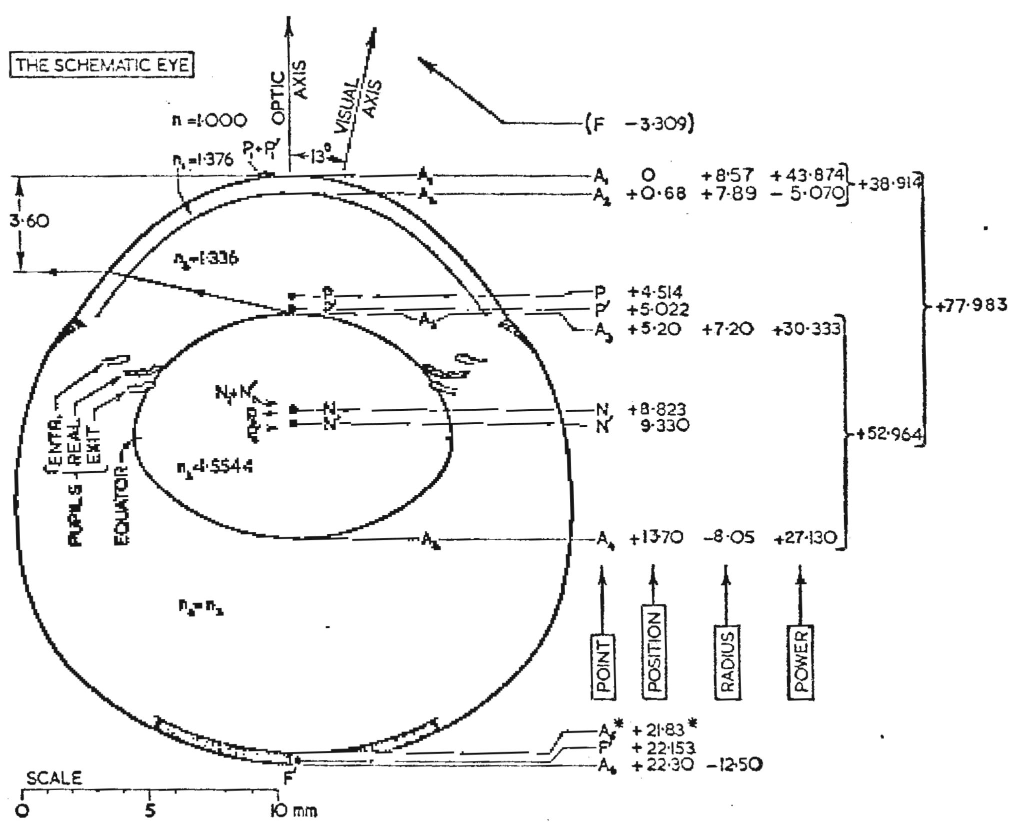


FIG. 5. The schematic eye: optical elements.

Their schematic eye is based upon an average cat weighing 3.5kg and having an eyeball length of 22.30 mm. Nearly all the measurements in their study were made on the excised eye. The measurements were made either with a dissecting microscope, or a micrometer. Photography was used to measure the shape and radii of curvature of the eyeball and of the lens, the position of the lens, and the vertex distances of the excised lens.

No study, to our knowledge, had been attempted on the developing cat using ultrasonography (USG) and keratometric techniques. Most of the studies using ultrasound were done utilizing humans and monkeys as subjects. Even in the schematic cat eye studies, there was no attempt to use USG to determine the axial length and correlate it with other optical measurements of the cat eye. Thus because of the extremely wide use of cats as experimental laboratory subjects, a study concerning the determination of axial length, radius of corneal curvature and lens size in the developing cat eye is of extreme value.

This study utilizes USG and Keratometry, procedures to establish the axial length, lens thickness, and radius of corneal curvature in the developing kitten from 5 days of age to day 150.

SECTION 2

SUBJECTS

Seven newborn kittens and three adult cats were used in this study. The kittens were not litter mates but were selected on the basis of the fortunes of birth, that is, they entered the experiment as birth made them available. Litter mates were assigned to other experiments. Measurements were begun as soon as the eyes opened.

Table IV shows the weights at which the animals were tested. Two kittens were only measured once each, dying before the next scheduled testing date. Some kittens developed conjunctivitis during the study and had to miss their scheduled test dates. Treatment with antibiotic ointments of Neosporin (Burroughs Wellcome), Neo-Cortef with Tetracaine (Upjohn), Chloromycetin (Parke Davis), and Mycitracin (Upjohn), were unsuccessful. The source of infection was not determined, but dampness may have contributed to the effect. Further investigation will be made should the infection return. The adult cats did not contact the infection.

TABLE IV

CAT	39	38	37	36	34	32	28	T-2	T-1	21
	165	211	193	280	182	217	270	2011		2480
		543	320	410	484	360		2430		2560
		603	610	750	500	495		2555		
		670	687	872	571	531			2721	
		716	805	967	643	630				
		843	842	1076	625					
			1071	1362	897					

Table IV weights of kittens and adult cats on date of keratometry and ultrsonography measurements. Weight values are stated in grams, cats were assigned number and letter tags which were worn for identification.

APPARATUS

The instrument used to obtain measurements of corneal radii was a Bausch and Lomb Keratometer, a single position instrument which gives readings in units of refractive power (diopters) that must be converted to radii in millimeters by taking into account the assumed refractive index of corneal tissue for which the instrument is calibrated. The conversion from power to radius was made by performing a calculation based on a mean refractive index for corneal tissue of 1.3375. When measurement was first begun on kittens the corneal radii were too short to be measured directly by the keratometer so the range was extended by placing a +2.75 Diopter accessory lens in front of the keratometer aperature. The power readings obtained with the accessory lens in place were corrected by adding a constant found by reference to steel bearing balls of known radius throughout the range of readings on the power wheels of the keratometer.

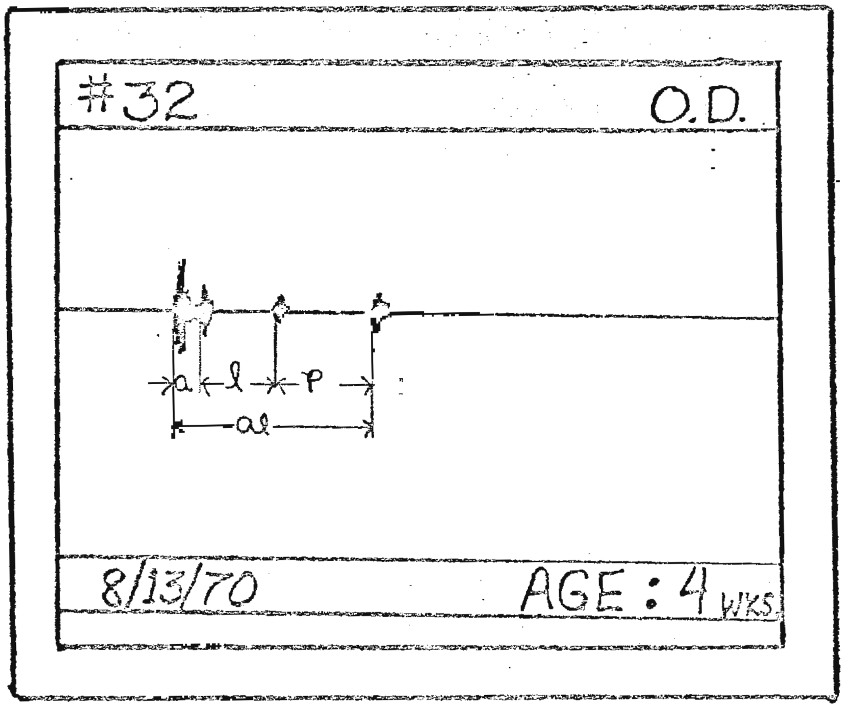
The ultrasound apparatus consisted of a Precision Sonics Company UTR-1 ultrasonic plug-in and a Tektronix Type 547 oscilloscope. The probe transducer was a plastic tube 55 mm long and 3.5 mm inside diameter. The ultrasound had a frequency of 4MHz and pulsated at about 250 impulses / sec., each with a duration of 5×10^{-6} sec. The echoes from the cornea, lens and posterior wall were recorded on the oscillograph screen (figure 6) where the pattern was photographed with a C-12 Polaroid camera attachment. Ultrasonographic calibration was checked at regular intervals by measuring a glass cube of known dimension and index. Measurements were taken off of the photograph with a traveling microscope, from Scientific Instruments, #93709. This linear photographic measure was then changed to actual ocular dimensions by using the method of calculation described in Appendix I.

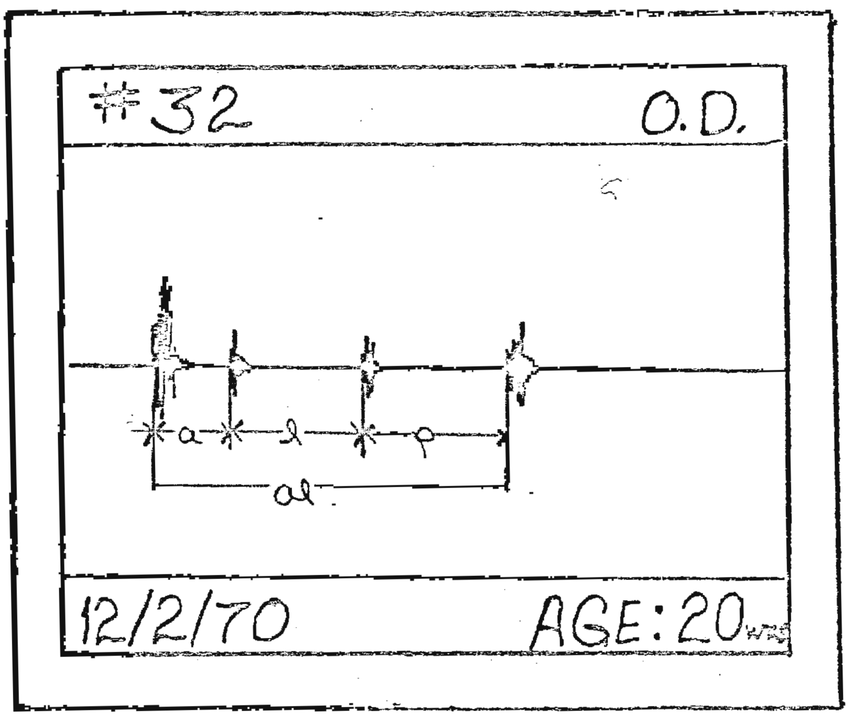
Of importance was that the ocular measurements calculated were based upon the rate of transmission of ultrasound through the aqueous, lens, and vitreous of the human eye as determined by Jansson (1963)[18] which have been shown to be essentially the same for the cat eye due to the similarity of the refractive indices found by Valentin (1879), Klingberg (1888, 1892), and Freytag (1910).[19] The refractive index of the vitreous was assumed to be the same as that of the aqueous. The instruments and principles used in this study were developed for use on human eyes, thus the results may be amenable to modification after the development of equipment designed especially for cat eyes.

Figure 6 consists of two examples of the ultrasonogram as photographed by the C-12 polaroid camera. The top photograph is of a subject 4 weeks old, the bottom of the same subject taken 16 weeks later. The ocular dimensions are represented as follows:

- a - Distance from anterior corneal surface to anterior surface of the lens.
- l - Thickness of lens, from anterior lens surface to posterior lens surface.
- p - Depth of posterior chamber, from posterior lens to posterior scleral wall.
- al - Axial length, from anterior corneal surface to posterior scleral wall.

FIGURE 6





PROCEDURES

The cats were examined at three week intervals beginning at the approximate age of 10 days, or on the day the eyelids opened. On the day of the examination the cats underwent an external examination to exclude any eye disease. Only healthy eyes were included in the study. The kittens were weighed and lightly anesthetized with an intraperitoneal injection of Sodium Nembutal at 0.1 cc/200 grams body weight or to effect. One drop of 0.1% Cyclogel was placed in the conjunctival sac. The head of the cat to be examined was hand-held by one experiment while the keratometric readings were taken and recorded by the second experimenter. This made it possible to obtain central readings of each eye, thereby compensating for changes in eye position with changes in position of the head. Keratometric measurements were taken in both the vertical and horizontal meridians of each eye, with three readings being taken in each meridian by each examiner.

Measurements of the axial length (from the anterior corneal surface to the inner scleral wall in the posterior pole) were next taken by ultrasound technique. The cat was placed on a table and the ultrasound probe was placed on the corneal apex. A drop of contact lens wetting solution on the probe tip completed the fluid coupling when the apex was touched. When the echo pattern on the oscilloscope was complete and each surface represented with sufficient amplitude, a picture was taken of the oscilloscope pattern and the procedure repeated on the fellow eye.

Baum (1956) has shown in animal experiments that no damage was caused to the tissues of the eye by ultrasound pulsations in the range of 0.25 w/cm^2 for five minutes, and 1.0 w/cm^2 for three minutes.[20] In the current study the period needed for making determinations did not last longer than approximately two minutes and thus the effect was considerably less than 0.25w/cm^2. No damage to ocular tissues was observed, on any of the subjects used in this experiment.

SECTION 3

RESULTS

KERATOMETRY

On the basis of a criterion test, (see appendix II), taken on the ten precision steel ball bearings by each experimenter, no significant difference was found in their accuracy of using the keratometer. It was therefore possible for all data taken by the two experimenters to be treated statistically as if one examiner had obtained all the data.

When corneal radius values were plotted against the weight of the cat on the day readings were taken, (figure 7), the relationship resulted in a curvilinear function rising to an asymptotic radius of approximately 8.4 mm. This latter value was used as an anchor point on the curve obtained from a random sample of five adult cats. In order to obtain a single corneal power value for one eye, the horizontal and vertical radius values were averaged. This power value in diopters was then converted to millimeters of radius. All radius values, then, are an average of six pooled readings taken by the two experimenters.

Figure 8 shows the average of the horizontal and vertical radius values plotted against the age of the cat in days from birth. Only the cats within 3 days of being the same age were used in this group, (table V). For example, at 85 days, data from five cats were available for comparison, and the maximum amount of variability shown was .65 mm between the steepest and flattest readings. Simple linear regression analysis indicates that 90.7% of the time the radius of curvature will be within $\pm$ .43 mm of the best fit line at a given age. Up to 150 days the relationship of radius to age of the developing cat is essentially a straight line function.

A plot of the average horizontal and vertical radii of curvature for the right and left eyes as a function of weight, (figures 9, 10, 11), indicates that the right and left readings differ by less than .1 mm in each of three representative cats from the total population. The graph of the readings of cat #36 (figure 10) shows the readings over the longest period of growth. The greatest difference between right and left eyes occured at a weight of 410 grams. The cross-over found in all graphs may well be a function of experimental error for they appear to occur at random weights.

Meridional differences for two cats which are representative of the total population were plotted against their developing weight values, (figure 12 & 13). The three measurements for each meridian taken by the two experimenters were again averaged and then plotted as the radius value for the horizontal and vertical corneal meridians. Differences between the two meridians at each weight are representative of the astigmatic findings for the cat's eye. Cat #36, showed an average difference of .04 mm., cat #37, .08mm.

ULTRASONOGRAPHY

The axial length of the eye for all cats used in the study (n = 12), was plotted against the body weight on the day of examination, (figure 14). Each point plotted represents the axial length of one eye. A pair of points indicates one cat. The resulting relationship is a curvilinear function rising to an asymptotic axial length of approximately 19.5 mm at a corresponding weight value of 1350 grams. The weight interval from 1400 to 2400 grams was lacking the associated axial length measurements which were needed to extend the asymptotic value through this area of the cats development. The cats shown on the graph at the weights from 2400 to 2600 grams were not of sufficient number to justify extention of the curvilinear function to a higher asymptotic position. It was felt that these adult values may constitute average values, since they did not agree well with the results of Vakkur, Bishop and Kozak (1962 & 1963). The axial length values for plotting were arrived at through computer analysis by formulas, (appendix I), adjusted for the particular velocities of sound in the ocular media.

Figure 15 illustrates the changes in radius of corneal curvature plotted as a function of growth in axial length. Both eyes of each cat in the study were used in the correlation analysis by simple linear regression. Results of analysis (appendix II) shows that 86% of the time at a given weight the axial length will be within $\pm$ .46 mm of the regression line at that weight. As the graph ends at the axial length of 20.0 mm the radius of curvature of the developing cat is again essentially a straight line function which, it is assumed, would approach an asymptotic value at some further stage of development.

Lens thickness was plotted against the associated axial length values for both eyes of each cat used in the study, (figure 16). Lens thickness values and those of the axial length were obtained from computer analysis by simple linear regression, and then plotted in millimeter values. The data was plotted around the best fit line obtained from computer analysis, and the resulte show that the asymptotic level of development for lens thickness was not reached at the point where the corresponding axial length level reached 20.0 mm. The graph represents the relationship of lens thickness to axial length which developed over an eighteen week period . Simple linear regression analysis again permitted a plot of the best fit line through the points. A correlation of (r = .915) indicated that 91.5% of the time at a given axial length the lens thickness will be within ± .37 mm of the best fit line. This value represents a range of ± 3 standard deviations about the regression line.

Figure 7, Average corneal radius vs. weight for all cats used in the study (n = 12) over the eighteen week growth period.

FIGURE 7

ALL CATS USED IN THE STUDY
AVERAGE CORNEAL RADIUS Vs WEIGHT

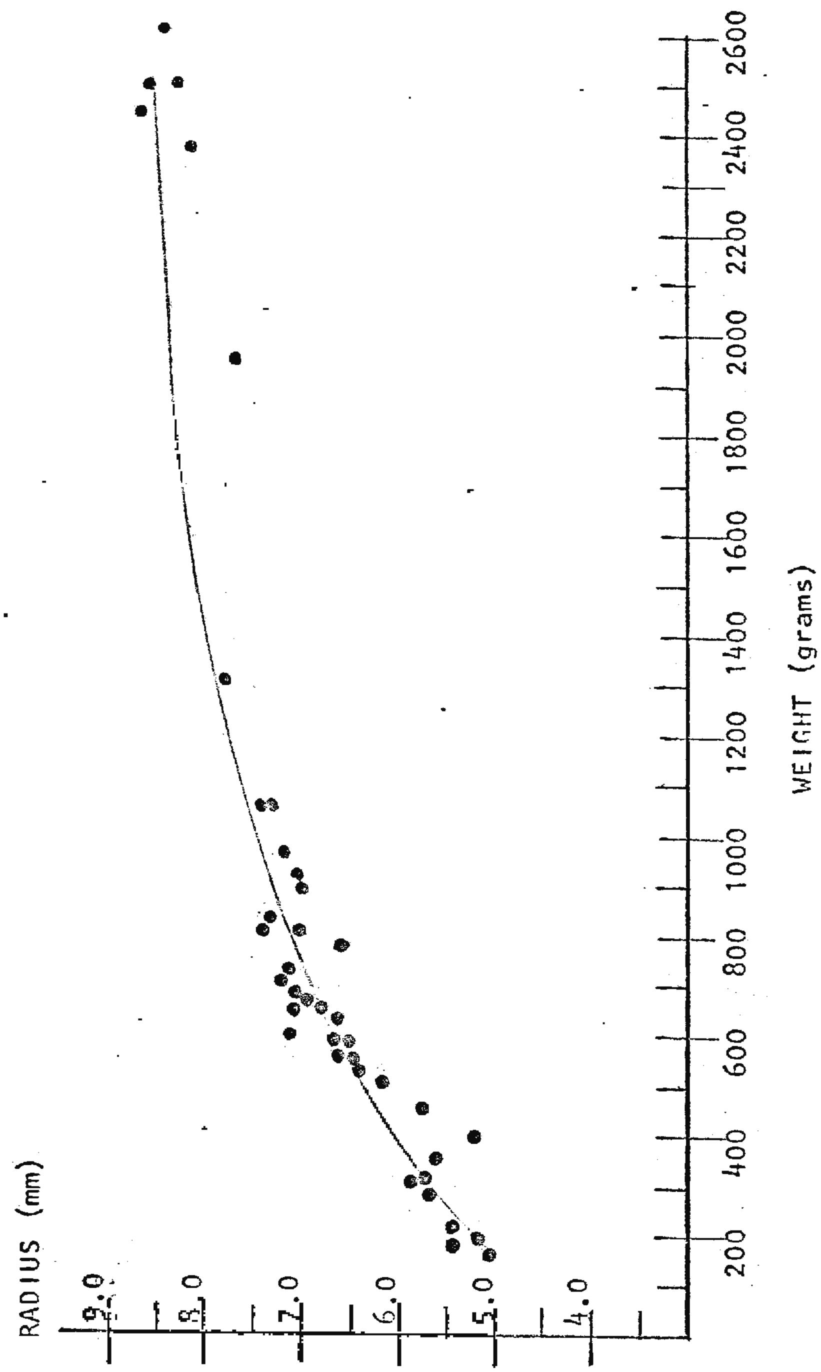


Table V, Grouping of cats within $\pm$ 3 days of being the same age. Also shown are the average ages in days for each group.

Figure 8, Corneal radius of curvature plotted against age of cat in days as shown in table one. (r = .907) Variation calculated for 3 standard deviations was $\pm$ .43 mm about the regression line.

TABLE V

CAT	31	32	34	36	37	38	39	AVERAGE
					12		11	11.5
			20	21				20.5
	34	36		33	33			34.0
		66	63	64	64	64		64.2
		86	84	85	85	85		85.0
		107	106	109	109	109		108.0
			115					115.0
			125	127	127	127		126.5
			147	148	148	148		147.7

CATS: 31, 32, 34, 36, 37, 38, 39.
CORNEAL RADIUS OF CURVATURE Vs AGE OF CAT (in days)

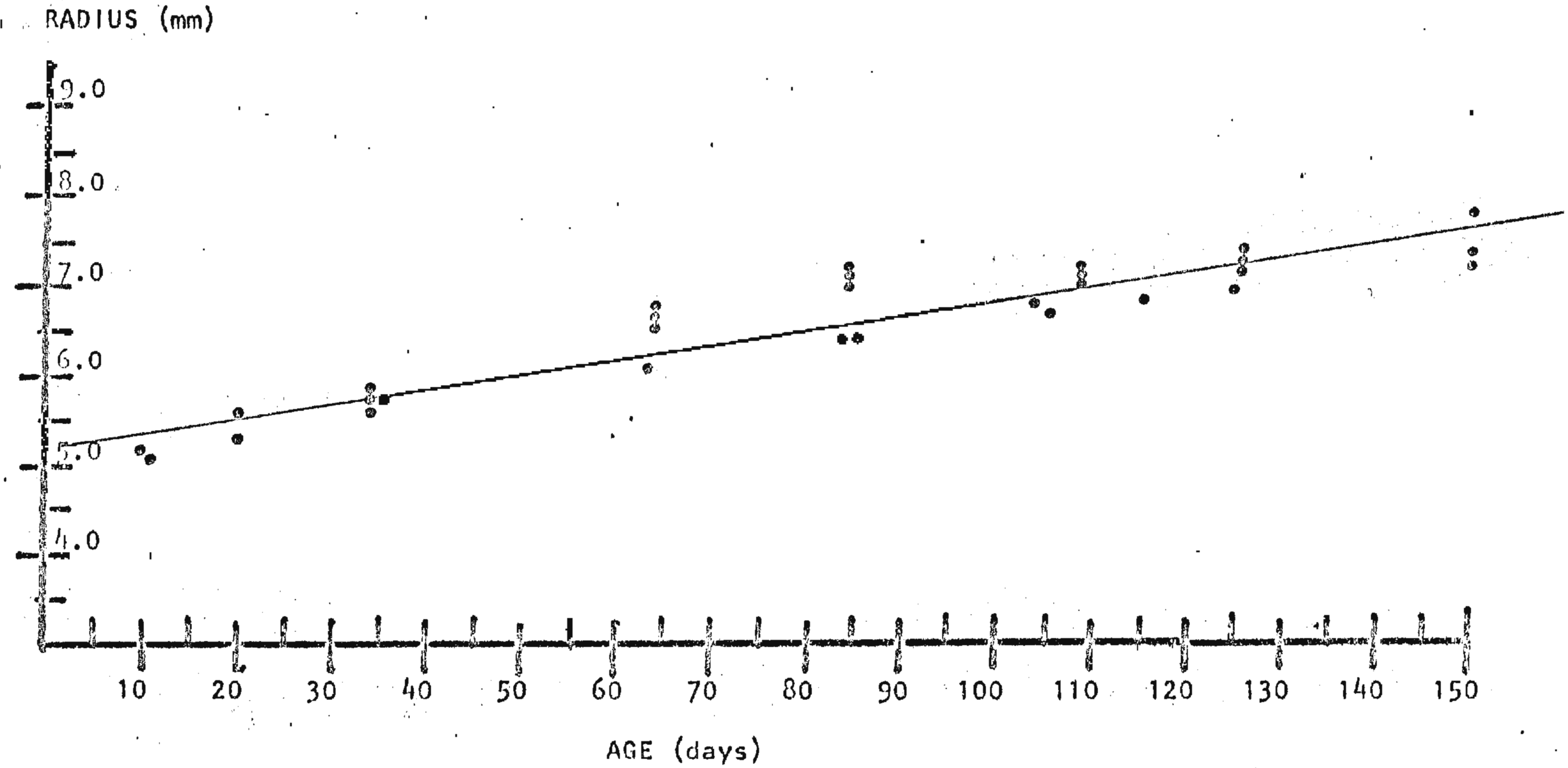


FIGURE 8

Figures 9, 10, and 11, Corneal radius of right and left eyes of cats #32, #36, and #38, as a function of weight. The solid line represents the findings on the right eye, the dotted line, those of the left. Each point represents the average of horizontal and vertical meridians for that eye.

CAT: #32
DIFFERENCE IN CORNEAL RADIUS OF RIGHT AND LEFT EYES, AS A (f) OF WEIGHT

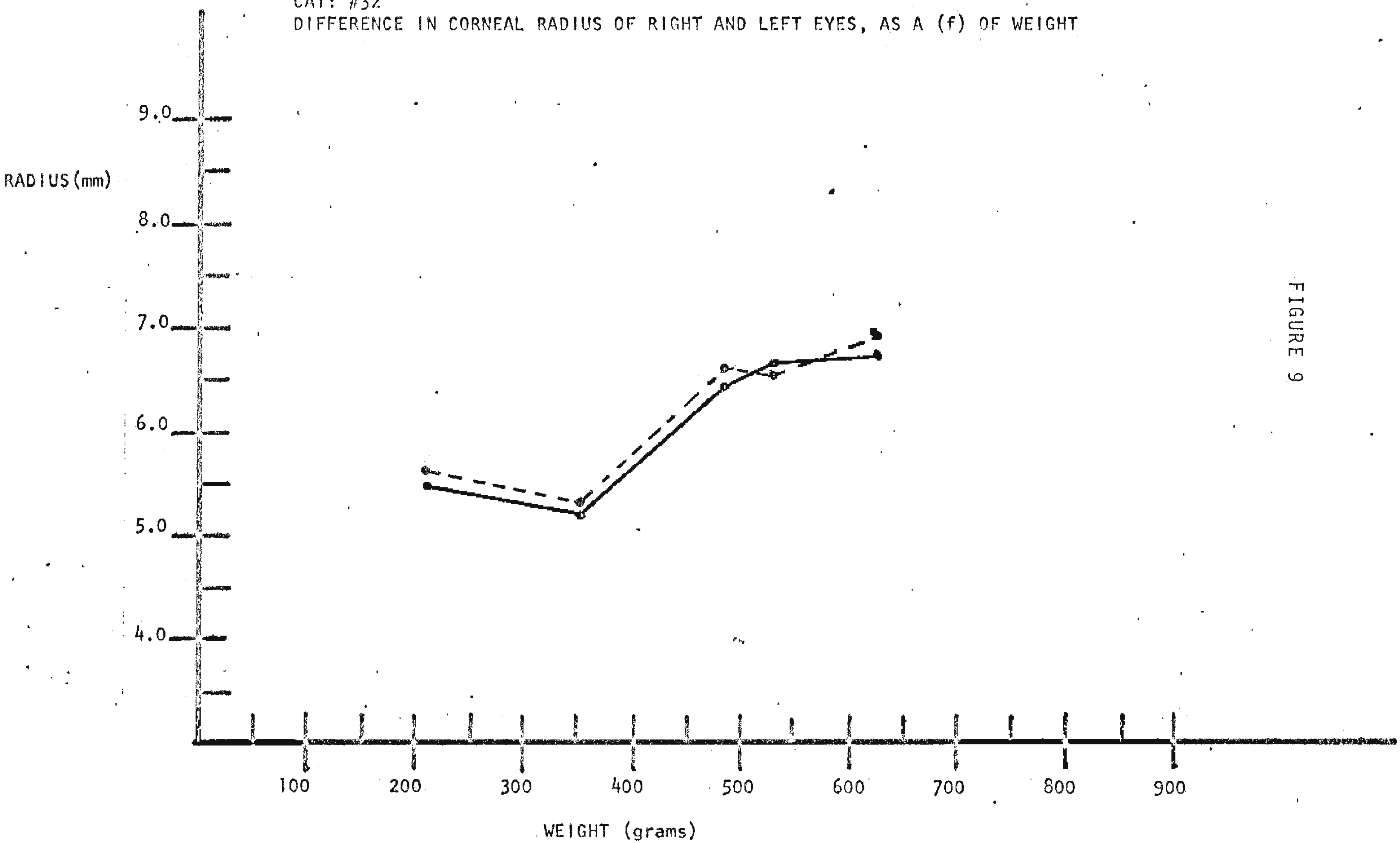


FIGURE 9

CAT: #36

DIFFERENCE IN CORNEAL RADIUS OF RIGHT AND LEFT EYES, AS A (f) OF WEIGHT

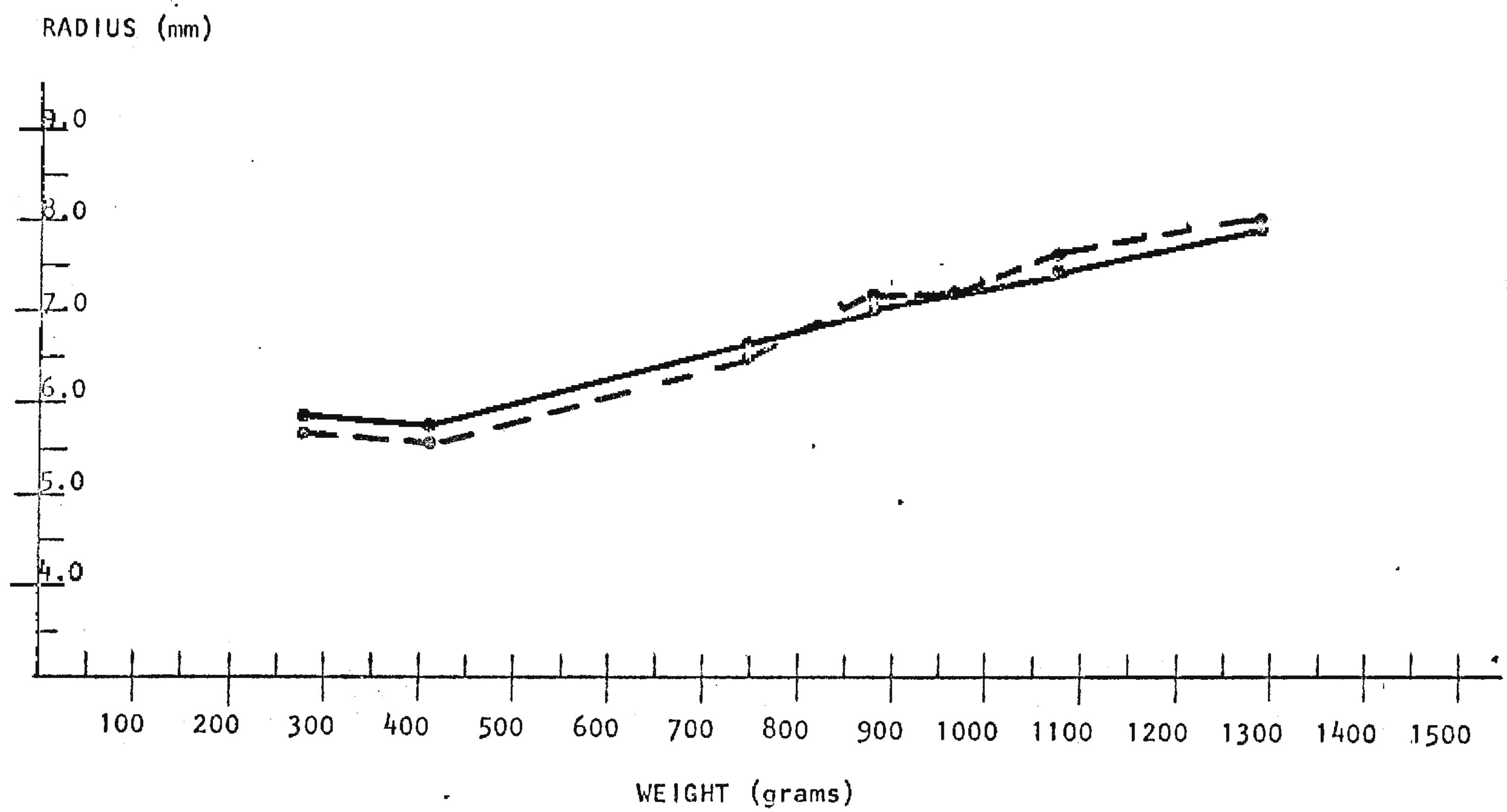


FIGURE 10

CAT: #38

DIFFERENCE IN CORNEAL RADIUS OF RIGHT AND LEFT EYES, AS A (f) OF WEIGHT

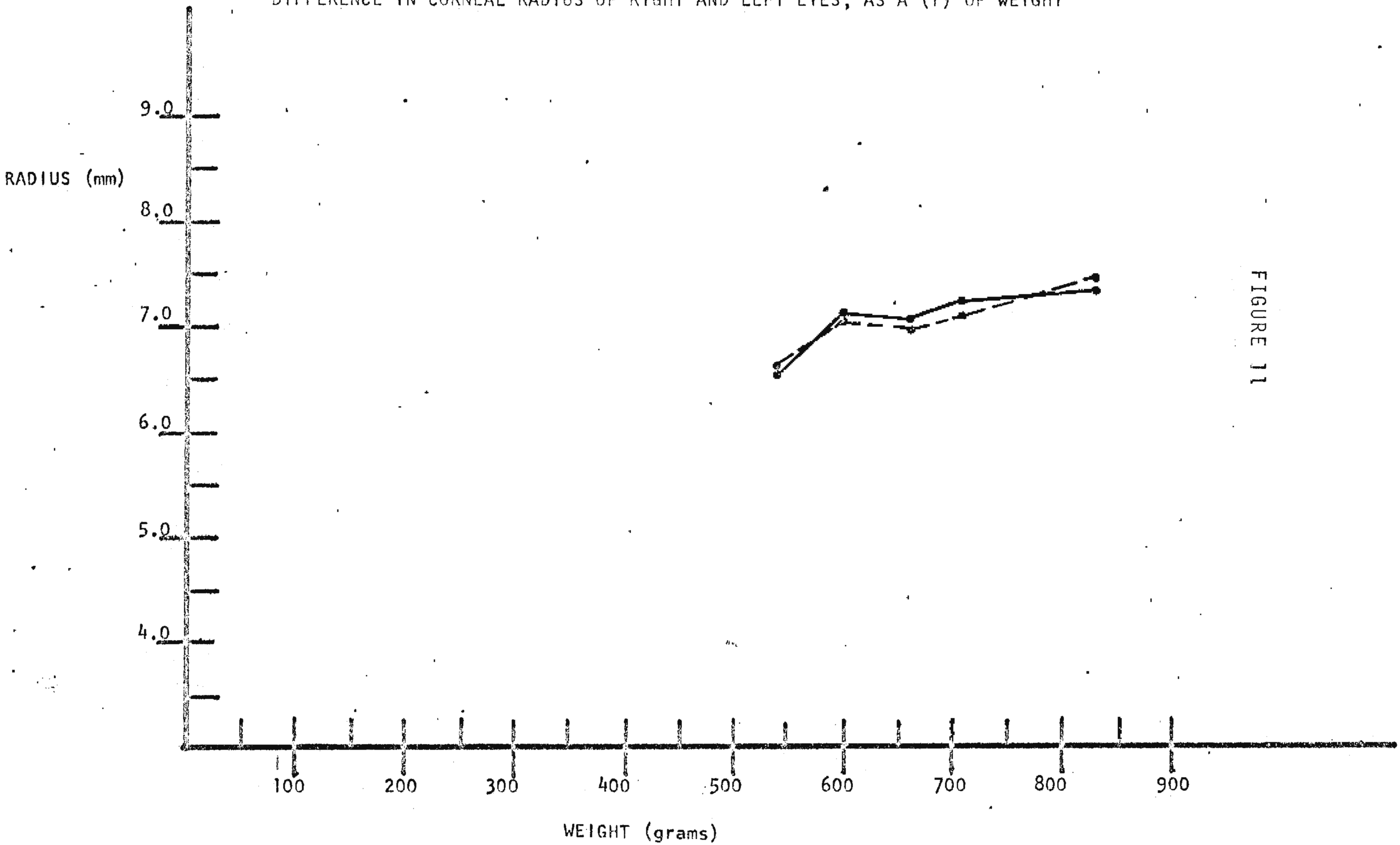


FIGURE 11

Figure 12 and 13, Astigmatic findings: Horizontal and vertical meridians as a function of weight. The dashed line represents the radius values for the vertical corneal meridian. (the lower line of the graph) Shorter corneal radius indicating greater power in the vertical meridian.

CAT: #36
ASTIGMATIC FINDINGS, RIGHT EYE
HORIZONTAL Vs VERTICAL PLOTTED AGAINST WEIGHT

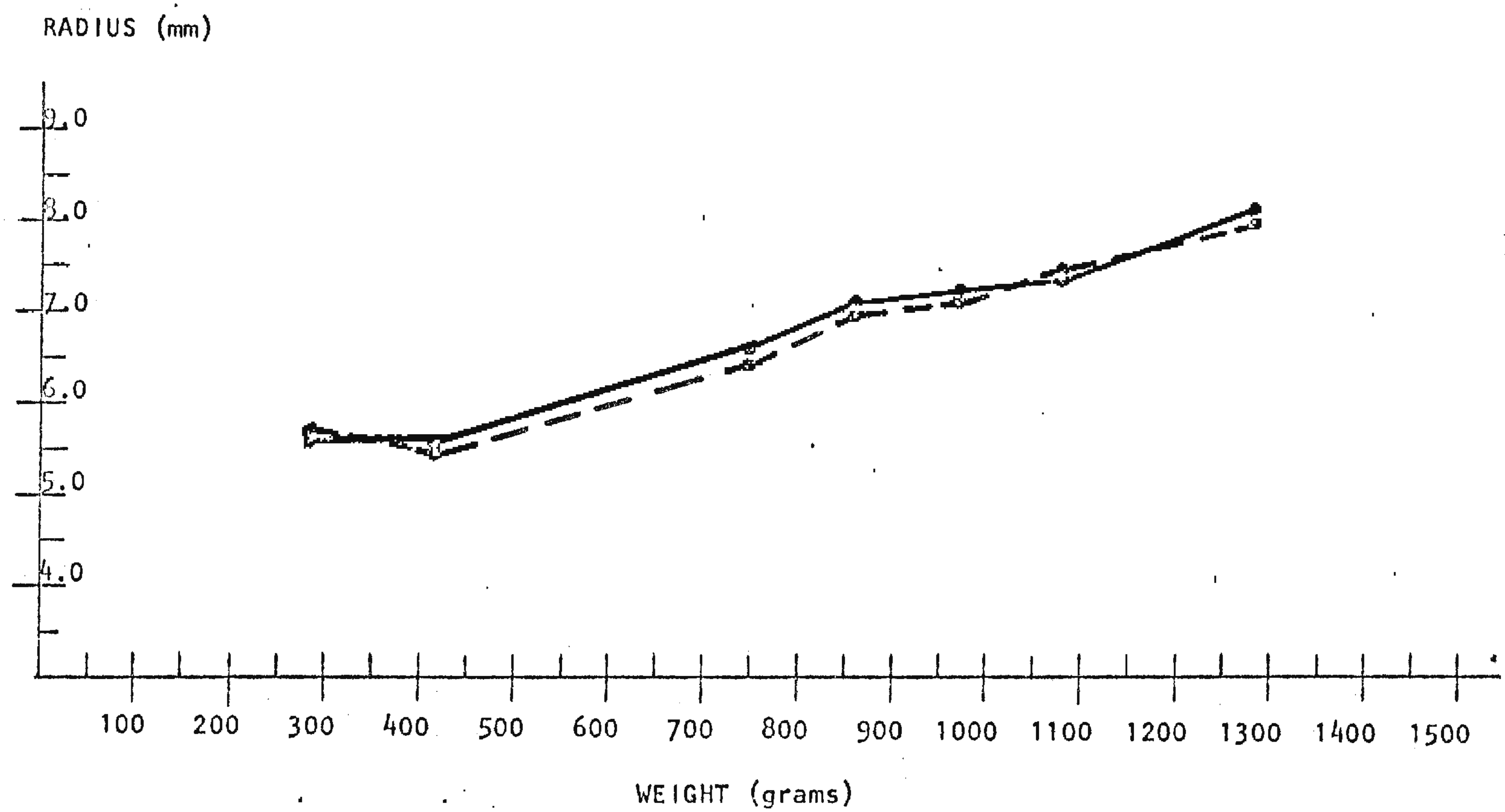


FIGURE 12

CAT: #37
ASTIGMATIC FINDINGS LEFT EYE
HORIZONTAL Vs VERTICAL MERIDIANS AS A (f) OF WEIGHT

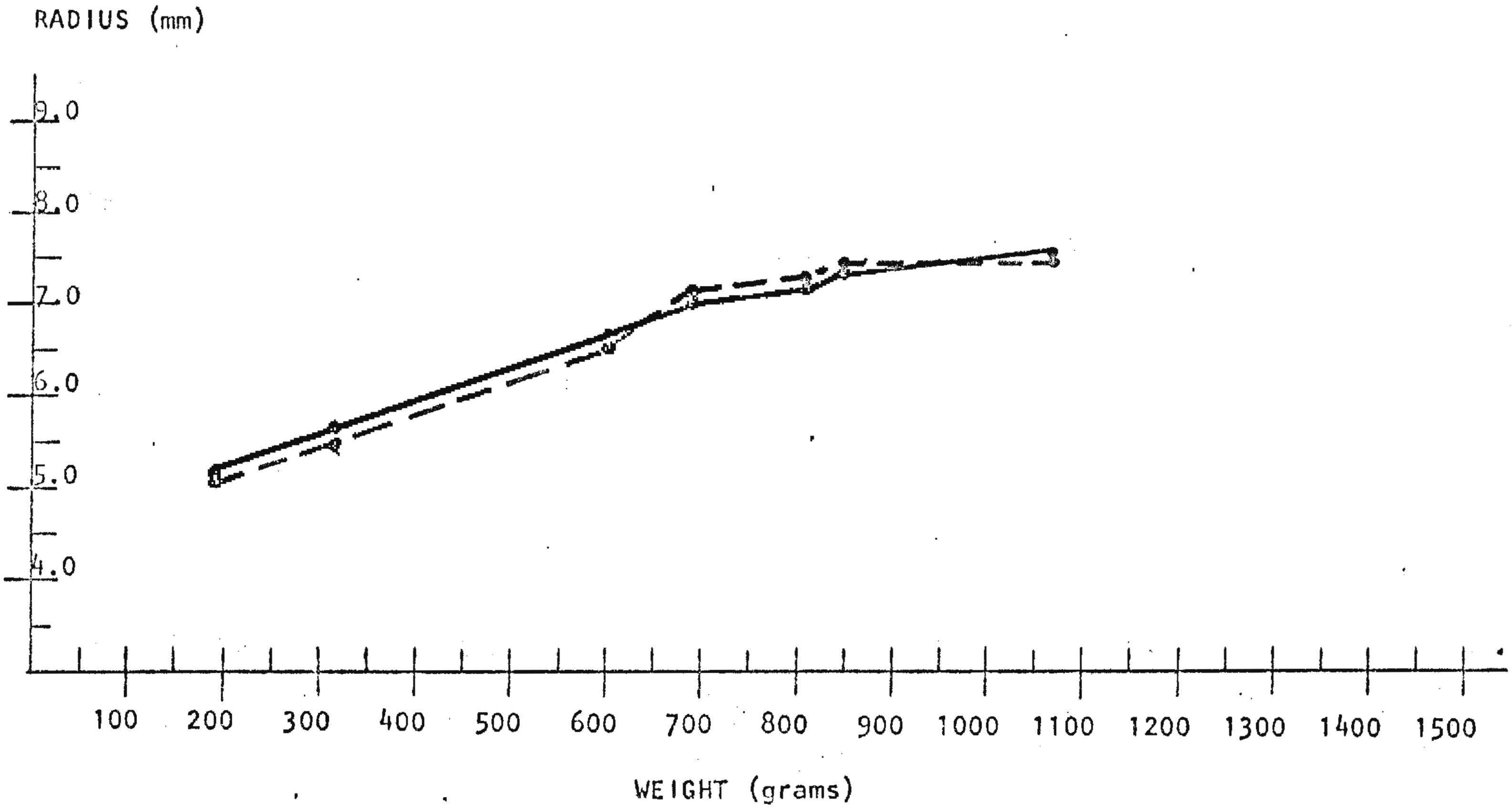


FIGURE 13

Figure 14, Axial length as a function of weight of cats (n = 12) over the eighteen week growth period. Both eyes of each subject are shown on this plot.

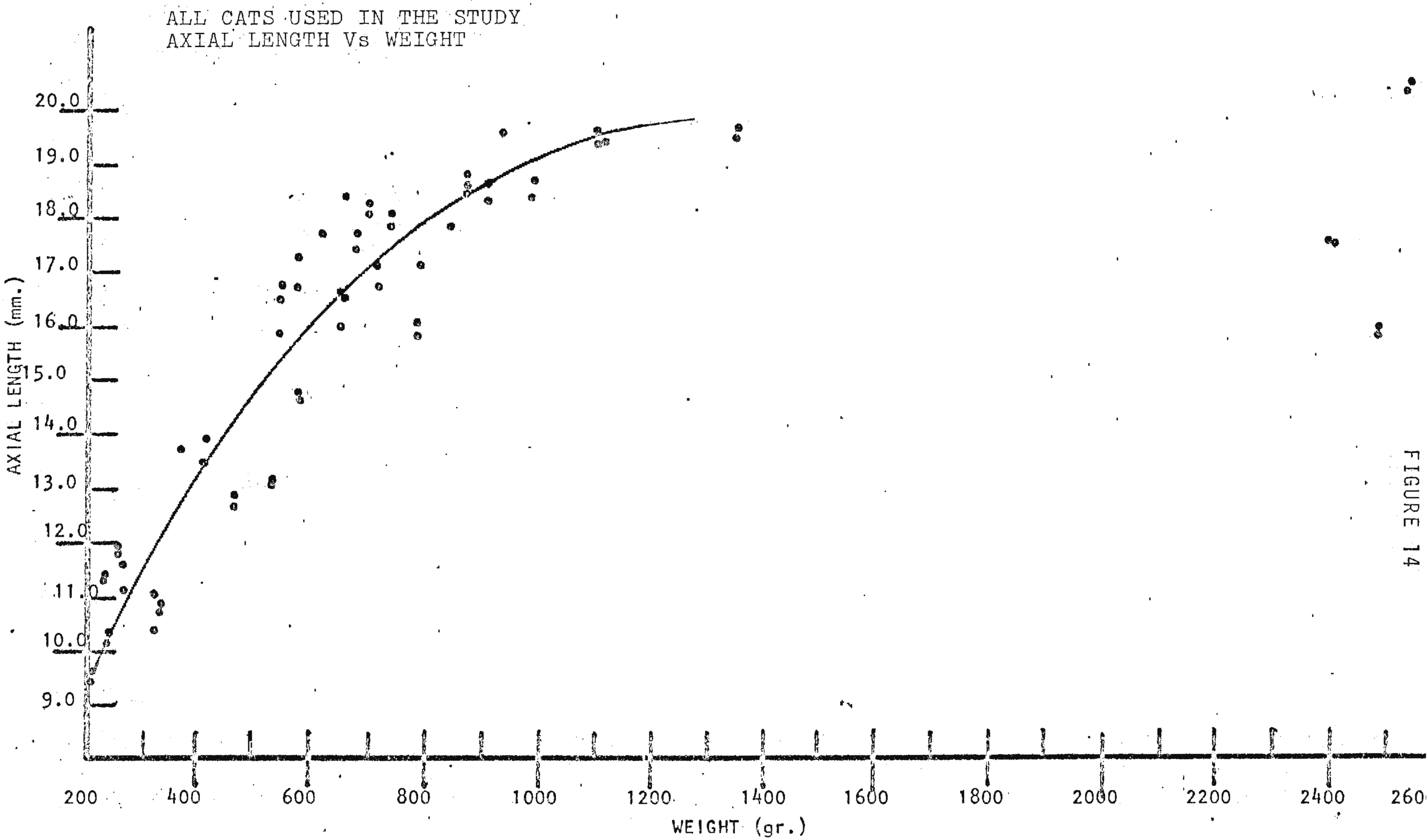

ALL CATS USED IN THE STUDY
AXIAL LENGTH Vs WEIGHT
AXIAL LENGTH (mm.)
20.0
19.0
18.0
17.0
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
260
WEIGHT (gr.)

FIGURE 14

Figure 15, Radius of curvature as a function of axial length for all cats used in the study (n = 12, x2 = 24 eyes) over the eighteen week period. Each point represents one eye. (r = .86) Variation calculated for 3 standard deviation was ± .46 mm about the regression line.

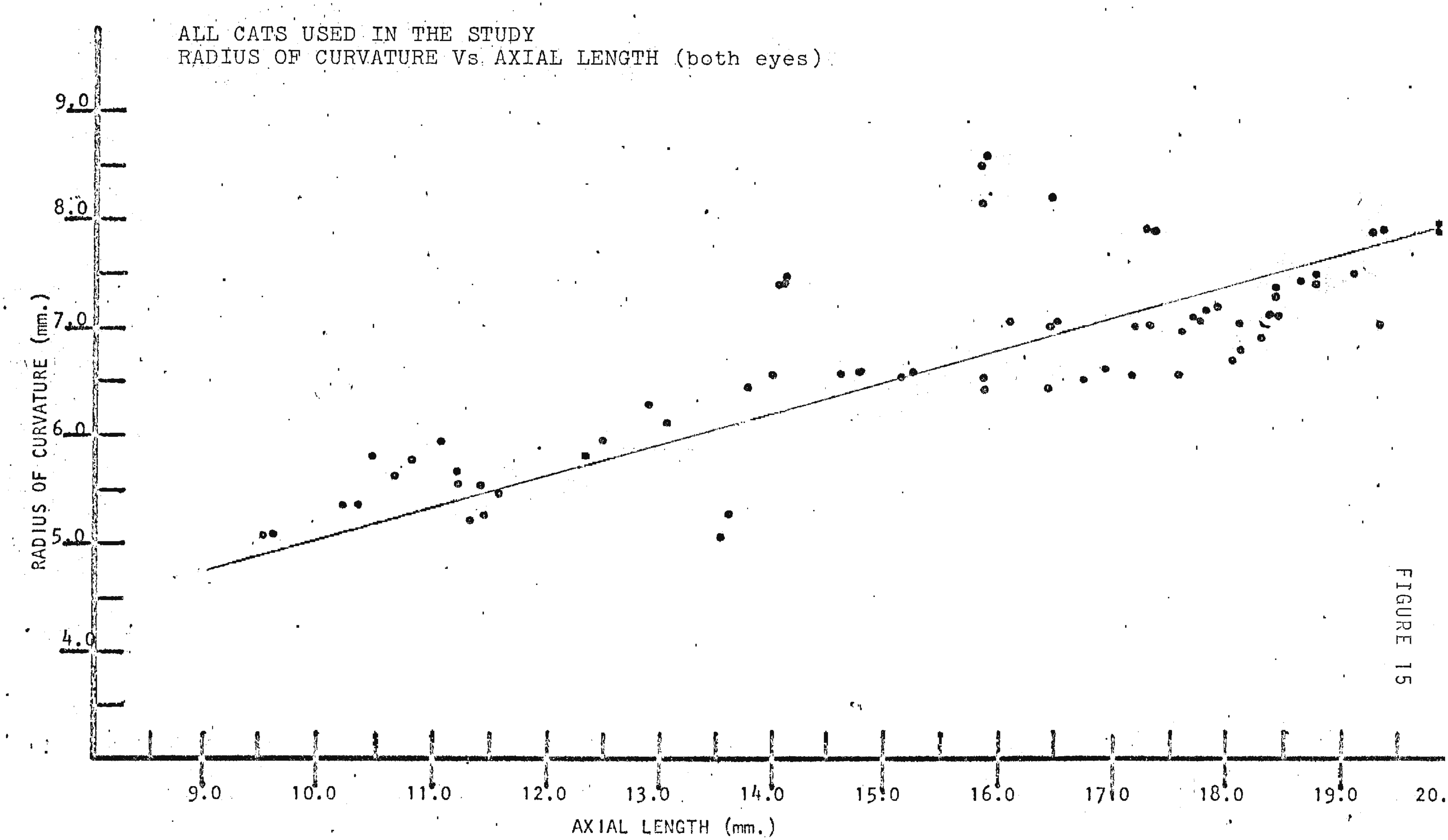

ALL CATS USED IN THE STUDY
RADIUS OF CURVATURE Vs AXIAL LENGTH (both eyes)
RADIUS OF CURVATURE (mm.)
9.0
8.0
7.0
6.0
5.0
4.0
9.0
10.0
11.0
12.0
13.0
14.0
15.0
16.0
17.0
18.0
19.0
20.
AXIAL LENGTH (mm.)

FIGURE 15

Figure 16, The lens thickness as a function of the axial length for all cats in the study (n = 12) over the eighteen week growth period. The data is for both eyes. (r = .915) Variation calculated for 3 standard deviations was ± .37 mm about the regression line.

ALL CATS USED IN THE STUDY
LENS THICKNESS Vs AXIAL LENGTH (both eyes)

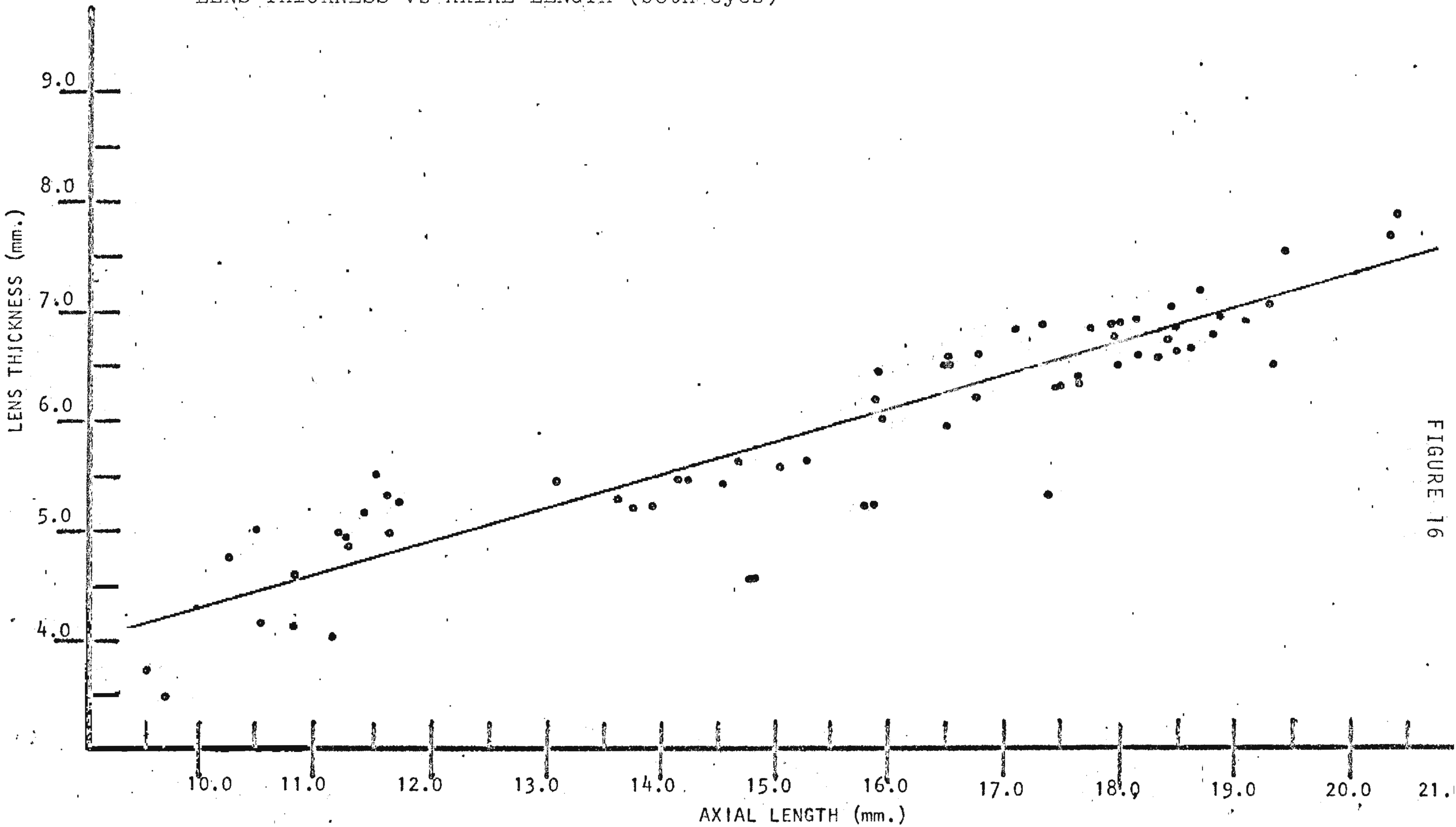


FIGURE 16

SECTION IV

DISCUSSION AND SUMMARY

The structural elements of the cat eye that need to be in definite relationship to each other during the growth period to allow adequate vision are the corneal radius of curvature, the lens thickness and position, and the axial length of the eye. This study has shown that all three elements change in a predictable and uniform manner.

Corneal radius of curvature as a function of weight of the cat (figure 7), resulted in a curvilinear function beginning at approximately 5.2 mm in kittens, when the eyes first open, and rose to an asymptotic radius of 8.514 mm at 390 days of age. The eyes of a kitten open naturally between the fifth and tenth day and the average weight at this time for the present study was 200 grams. Although the measurements in this study continued for only 150 days, the asymptotic value plotted for figure 7 was obtained by measuring 5 adult cats. This point served as an anchor for predictive purposes. Radius changes occurred most rapidly from birth to approximately 1100 grams or 130 days of age. From this point the radius of curvature increases at a slower rate, approaching the asymptotic value in the adult at approximately 2500 grams.

The average weight of the cats in the study of Vakkur, Bishop, and Kozak (1963) was 3490 grams; they found the radius of curvature to be 8.57 mm, while the average weight of the cats in the present study having a radius of 8.576 mm was 2520 grams. This suggests that above approximately 2500 grams the radius of curvature is not a function of weight or age as the corneal radius no longer continues to increase steadily. It is probably for this reason that Vakkur, et. al. found only a weak positive correlation between radius of curvature and weight for the cats in their study, which ranged between 2200 and 5300 grams.

The power of the cornea was assumed to be spherical because the difference between the vertical and horizontal meridians was found to be .08 mm or less. Vakkur, et. al. also found the cornea essentially concentric. It is not, however, possible to state from the present study, whether all cats have essentially spherical corneas. Further research on larger populations is needed. The average corneal power, for the adult cats was 39.375 D for the radius of 8.576 mm. This power is in close agreement with the power of 38.914 D for a radius of 8.57 mm found by Vakkur and Bishop (1963), and the power of 39.78 D for a radius of 8.48 mm found be Hartridge and Yamada (1922) in their adult cats. In the latter study the corneal radius measurements were also obtained with the keratometer, whereas Vakkur and Bishop used curve matching by photographs.

A comperison of the corneal radius of curvature with axial length (figure 15) over the period of development yields a high positive correlation (r = .86) for eyes ranging from 9.6 mm to 20.65 mm in length. These findings are in agreement with the study done by Vakkur, Bishop and Kozak (1963) who also found a high positive correlation between the corneal radius of curvature and axial length. Because the axial lengths in their study of adult cats ranged from 20.0 mm to 23.5 mm, their findings could be considered an upper extension of the present study.

These experimenters found the axial length and the weight of the cat to be only weakly correlated. The current study shows the axial length of the eye and the weight of the cat to be related directly as a curvilinear asymptotic function. These results suggest that during the cat's developmental period of 200 to 1400 grams weight a higher degree of correlation exists between axial length and weight than at higher weights of 2,000 to 5,000 grams as in the study of Vakkur, _et_. _al_.

The lens thickness increased from 4.5 mm when the eyes first opened to about 7.5 mm in adult cats. Comparison of the lens thickness to axial length revealed a high positive correlation ($r = .915$) over the weight range of 200 to 2555 grams. Vakkur, _et_. _al_. found only a weak positive correlation between lens thickness and axial length over the weight range of 2,000 to 5,000 grams for the cats in their study. We attribute the variation in the degree of correlation to the difference in weight ranges of the studies. The lens thicknesses found in their study ranged from 8.05 mm to 9.0 mm, or an average value of 8.49 mm, while the highest value for any one cat in our study was 7.52 mm and the average much less. Again we attribute this difference to result from differences in weight ranges of the studies, although it can be noted that the two studies do again blend well and provide an extended picture when considered together.

Although the number of kittens used in this study were small, further research is planned, not only to replicate the measures and functions already obtained, but also to extend the curves to their expected adult asymptotic values.

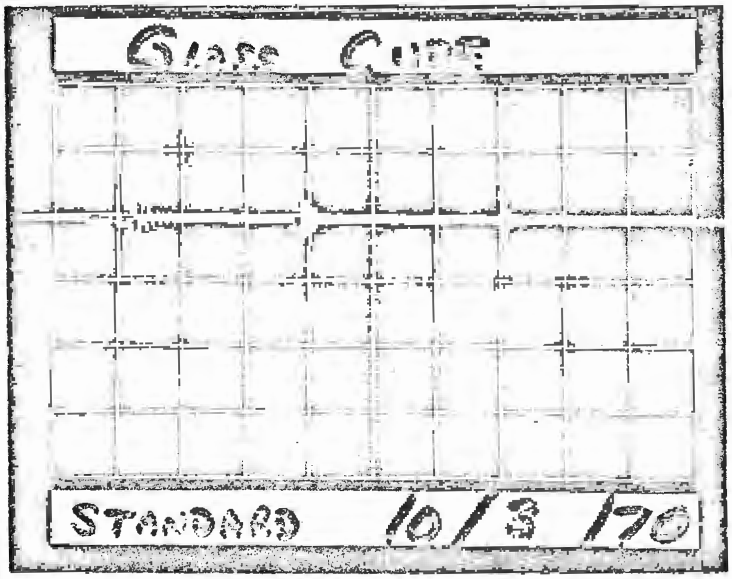
RECOMMENDATIONS

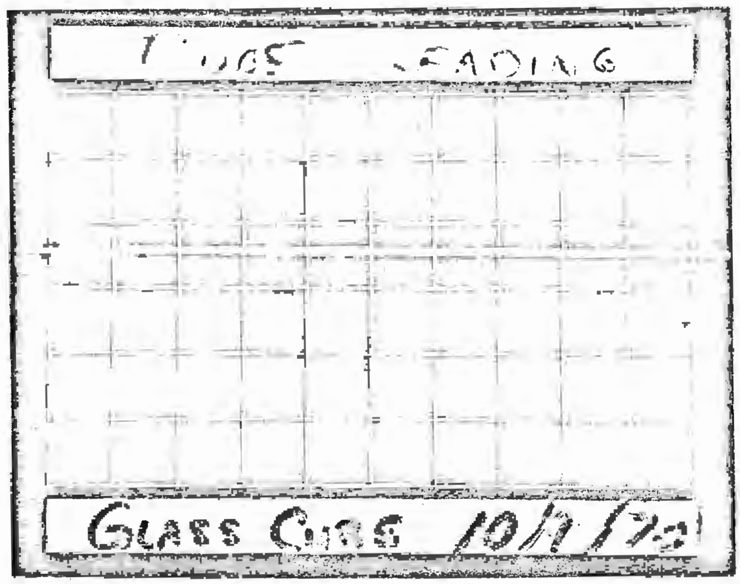
In addition to the corneal radius of curvature, the thickness of the lens, and the total length of the eye, the keratometric and ultrasound data provides information on the anterior and posterior chamber depth and the position of the lens. From this data the actual power of the corneal surface and the lens can be calculated. Thus from the information provided in this study most of the schematic values for the adult cat eye obtained by previous experimenters can be confirmed or compared and much can be learned about the developing visual system of cats from birth to maturity. It is the desire and recommendation of the authors that the potential of the data provided by this introductory study be fully realized and used in supplementary research.

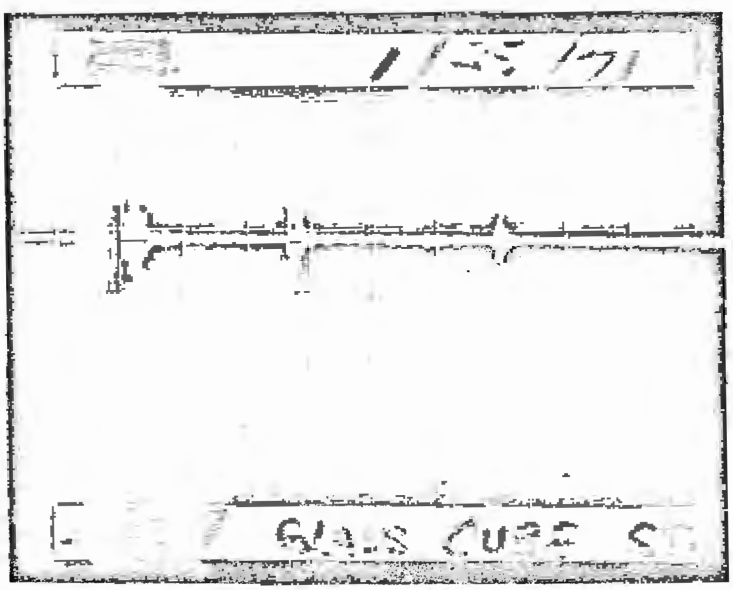
A P P E N D I X   I

ULTRASONOGRAPHY DATA (raw data)

The following are copies of photographs taken by a C-12 Polaroid camera showing location and relationship of ocular structures. Each photograph contains the number of the subject and date of examination. The first three photographs are examples of measurements taken on a glass cube used for calibration of the ultrasonograph. At the back of this appendix is shown the method of calculation used to change linear photographic measures to actual ocular dimensions.


GLASS CUBE
STANDARD 10/3/70


GLASS CUBE 10/11/70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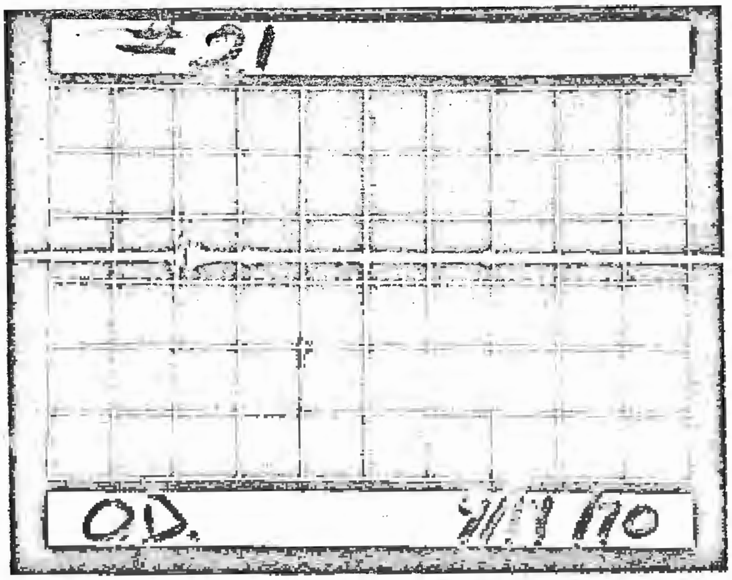
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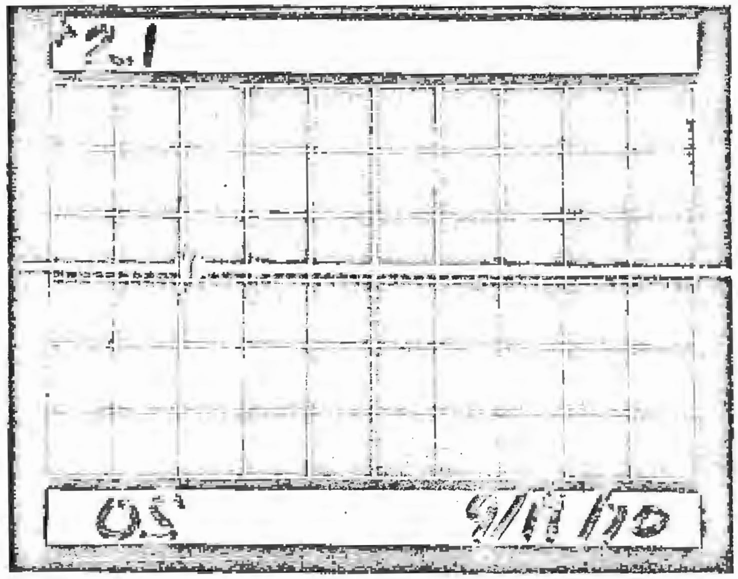
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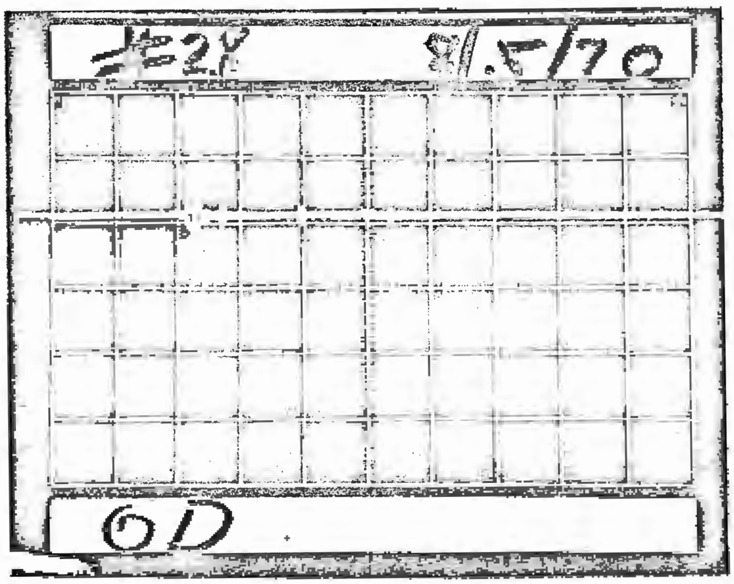
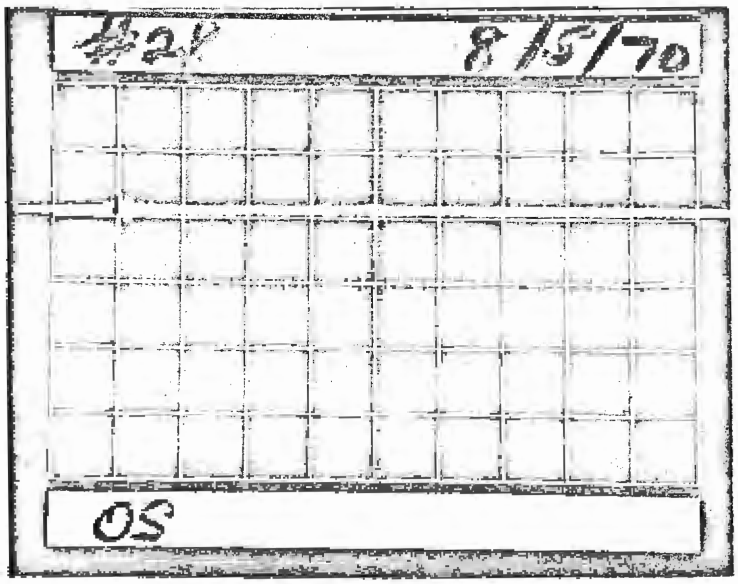

8/5/70
OD


8/5/70
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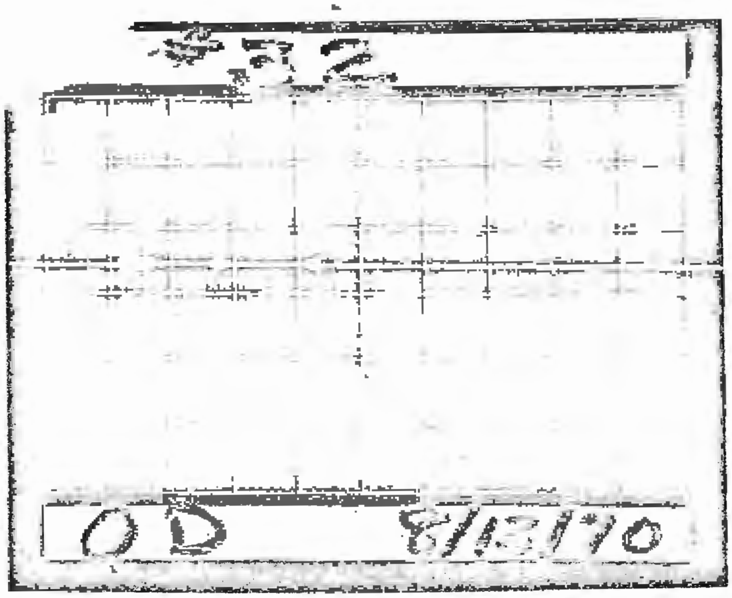
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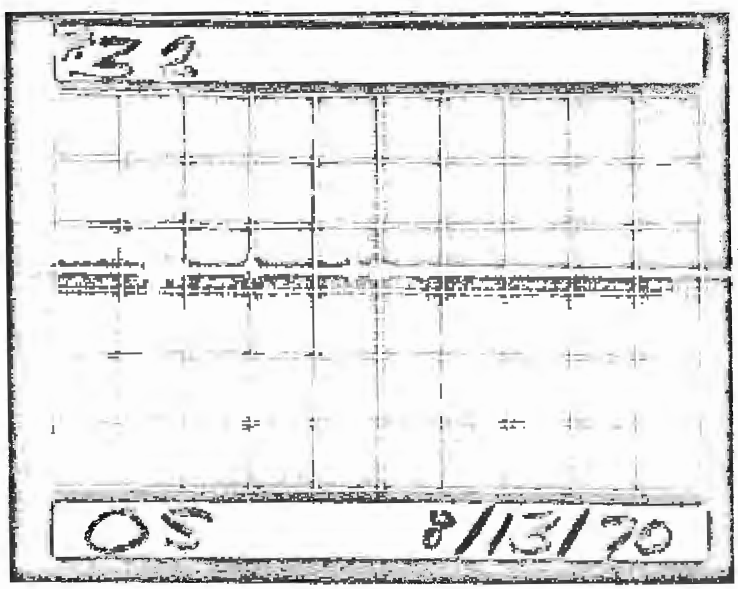
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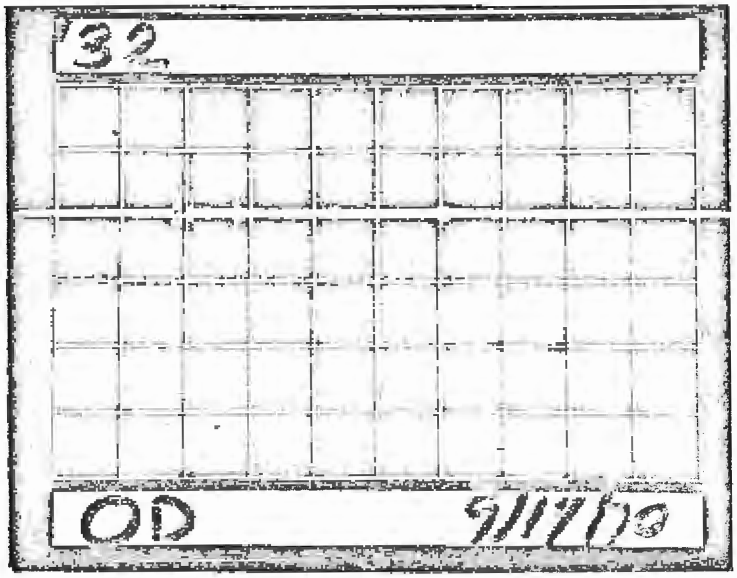
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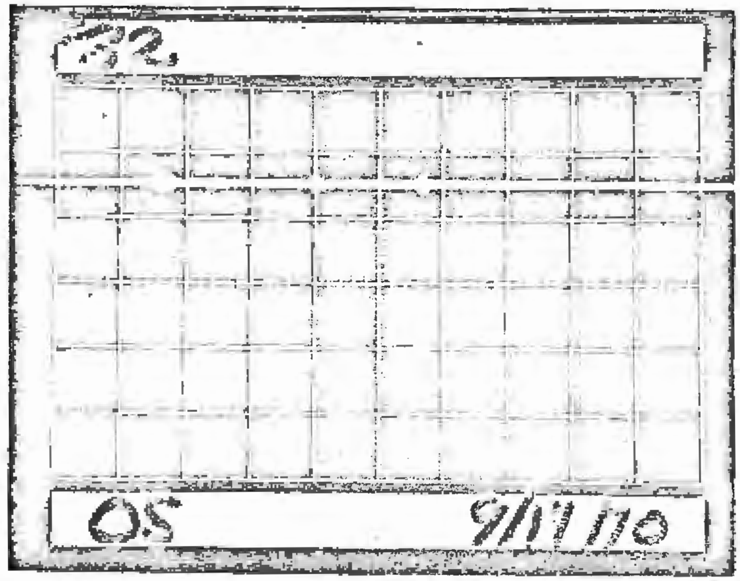
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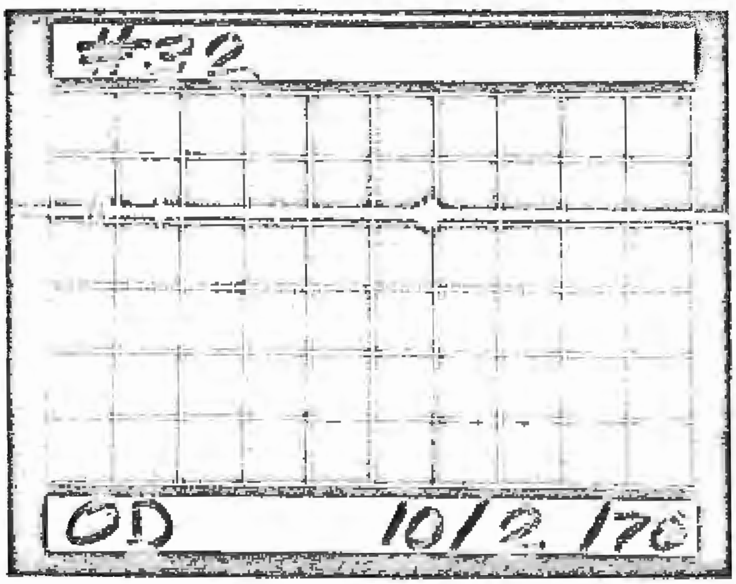
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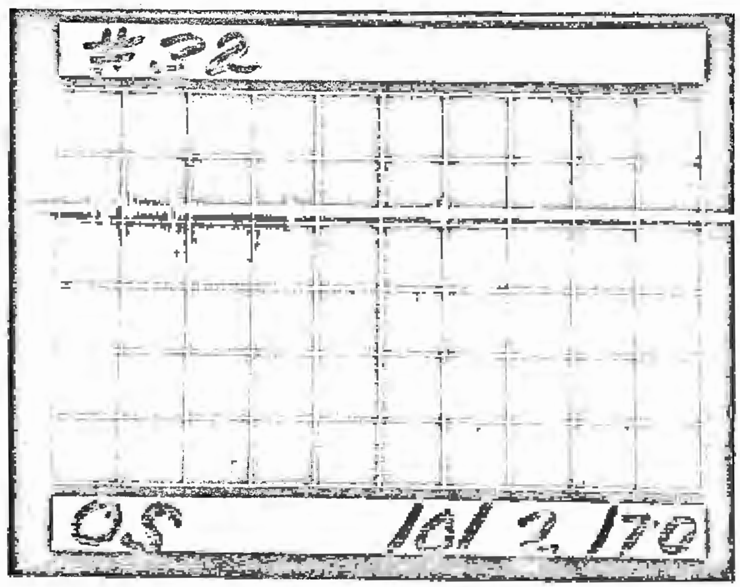
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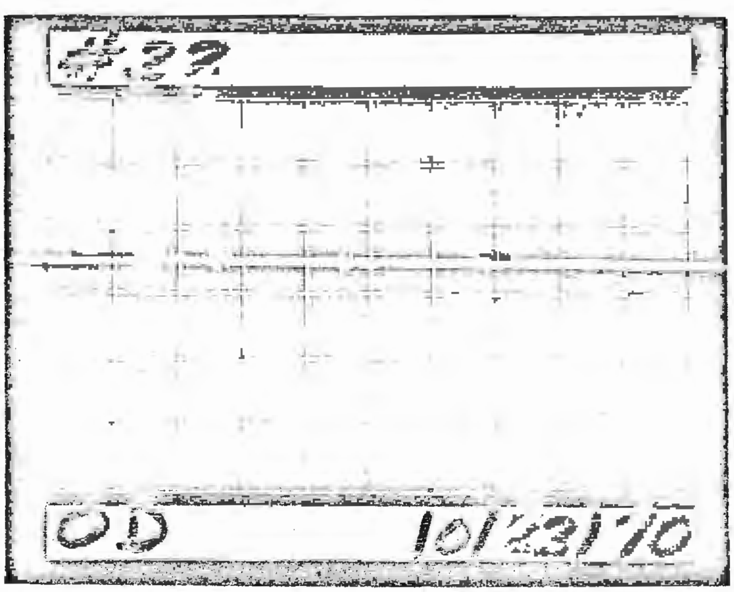
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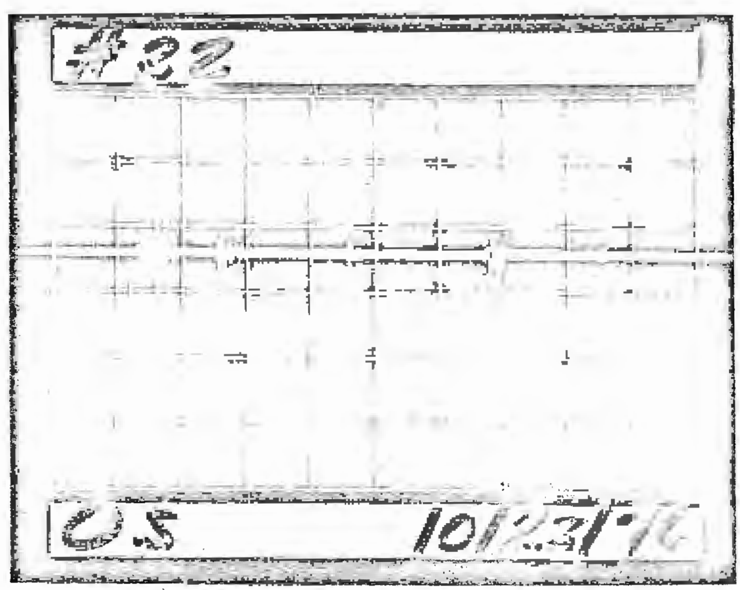
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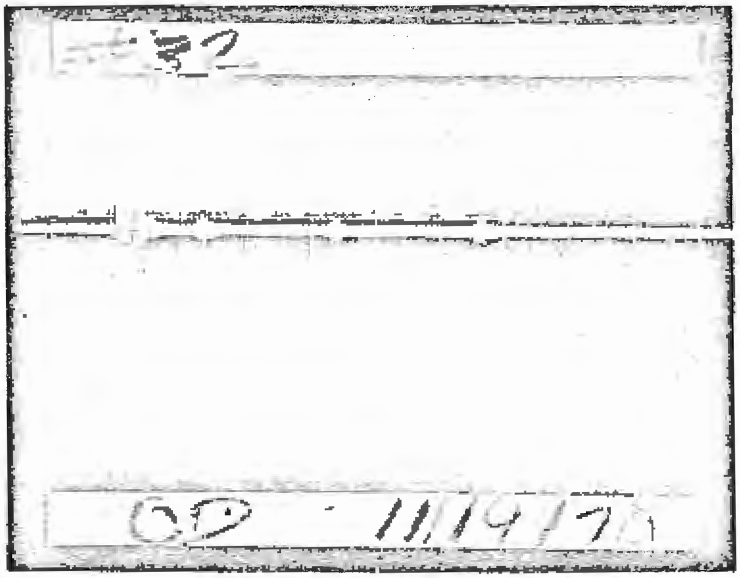
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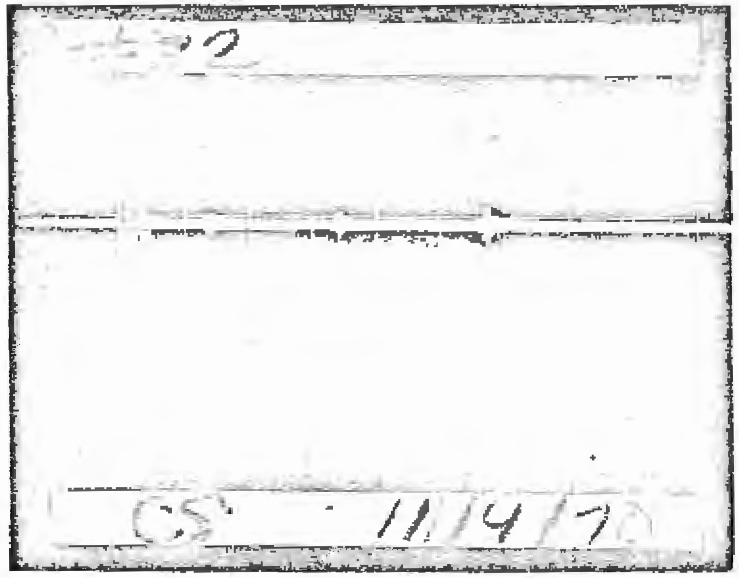
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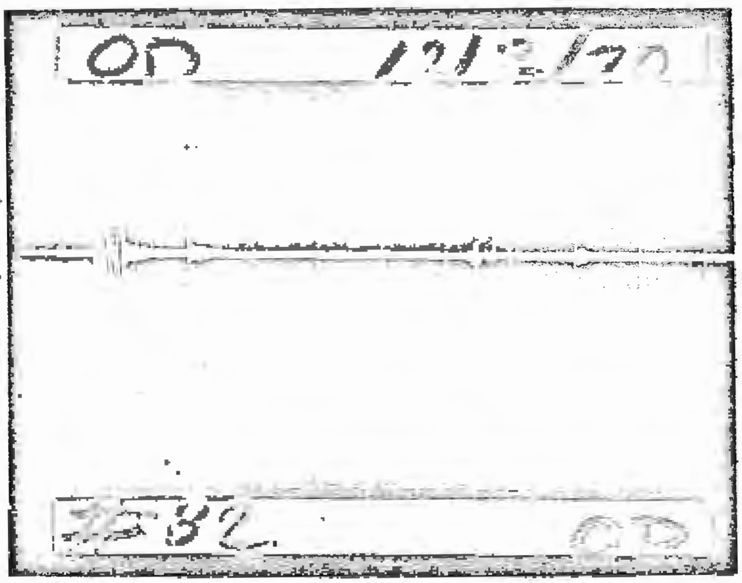
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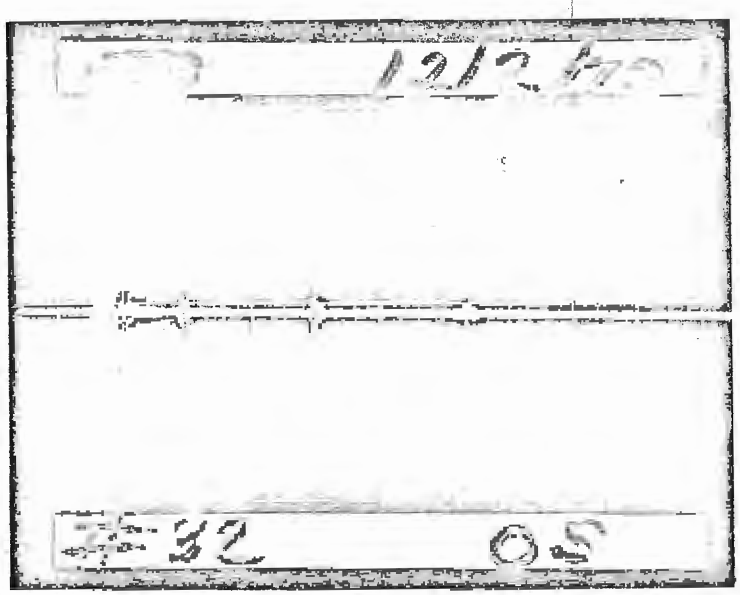
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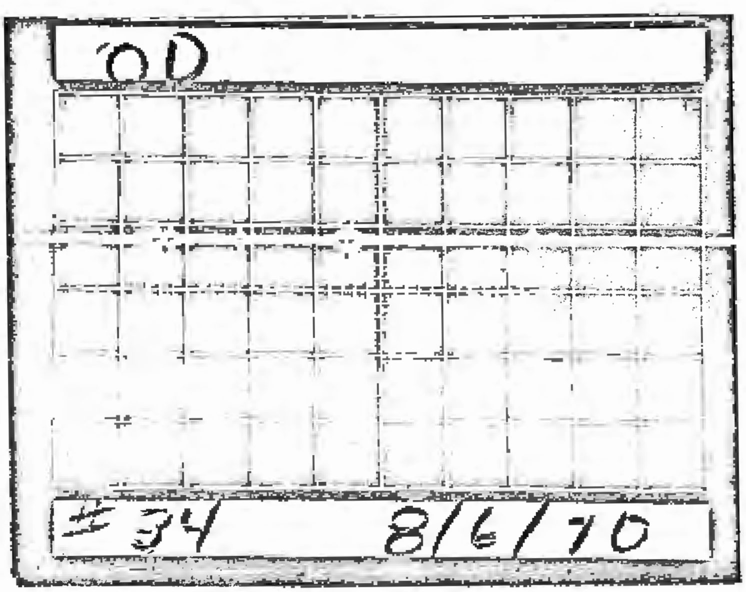
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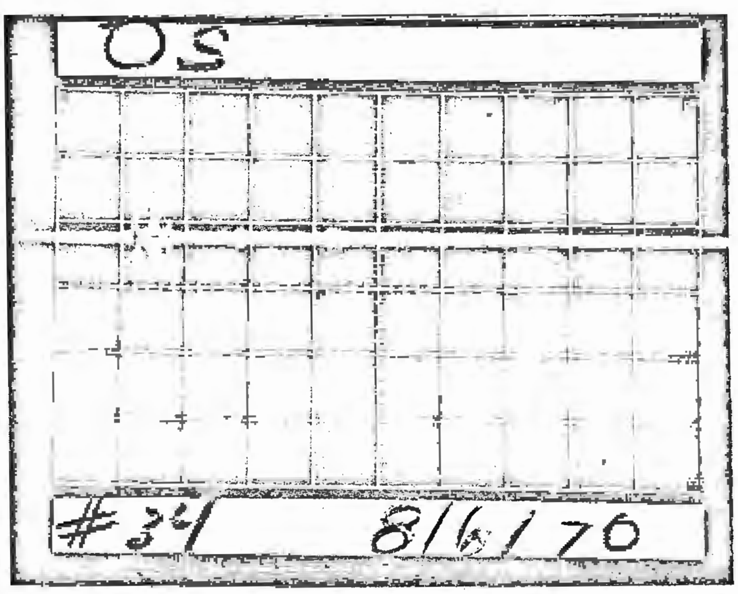
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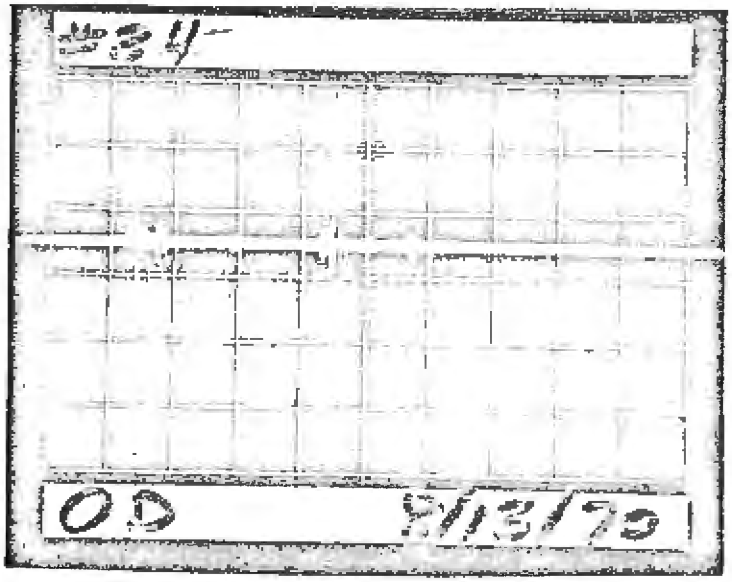
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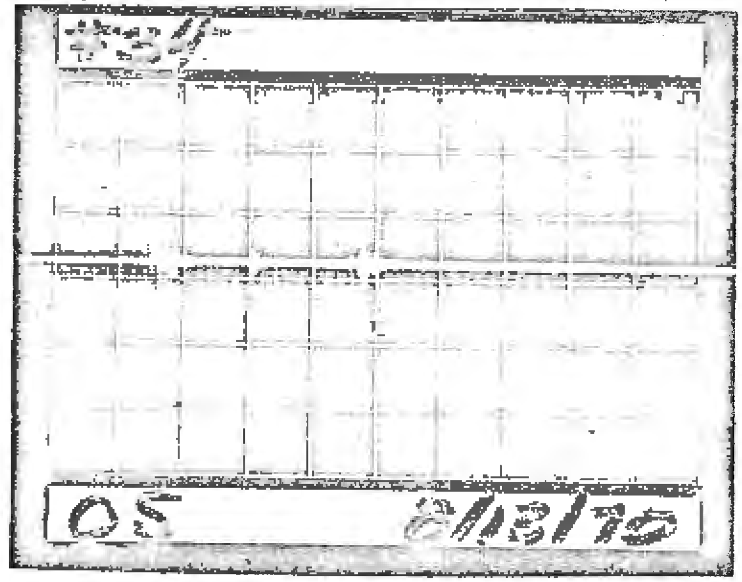
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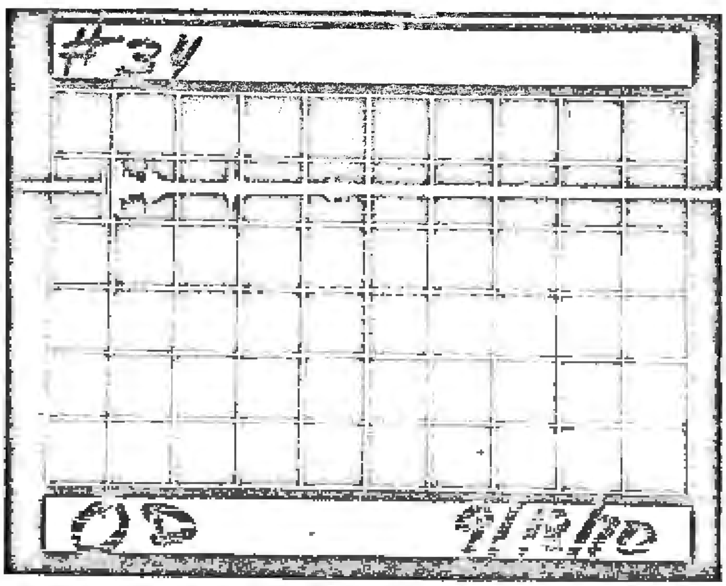
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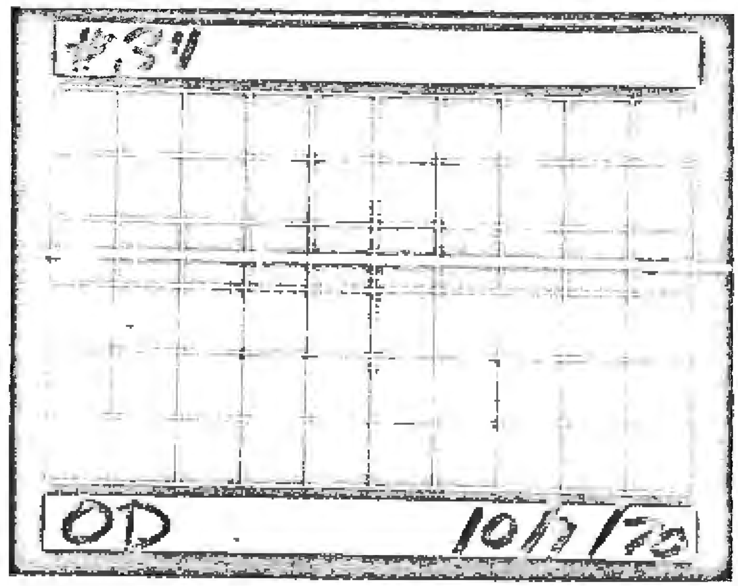
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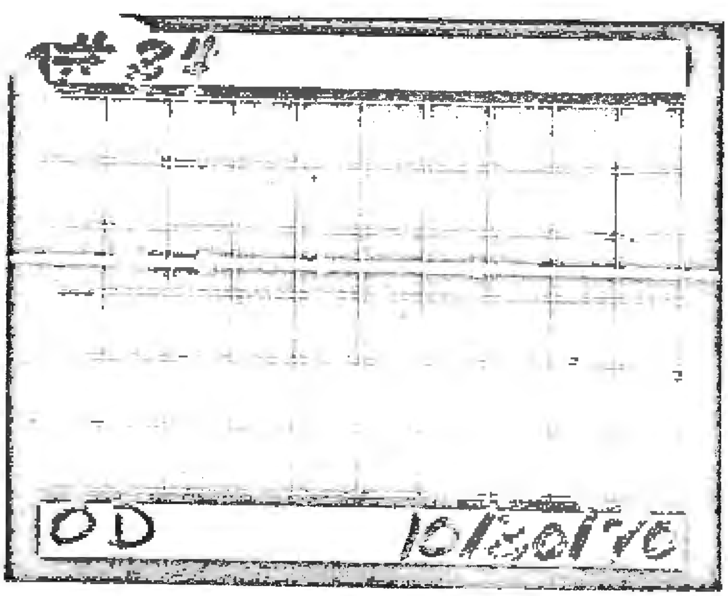
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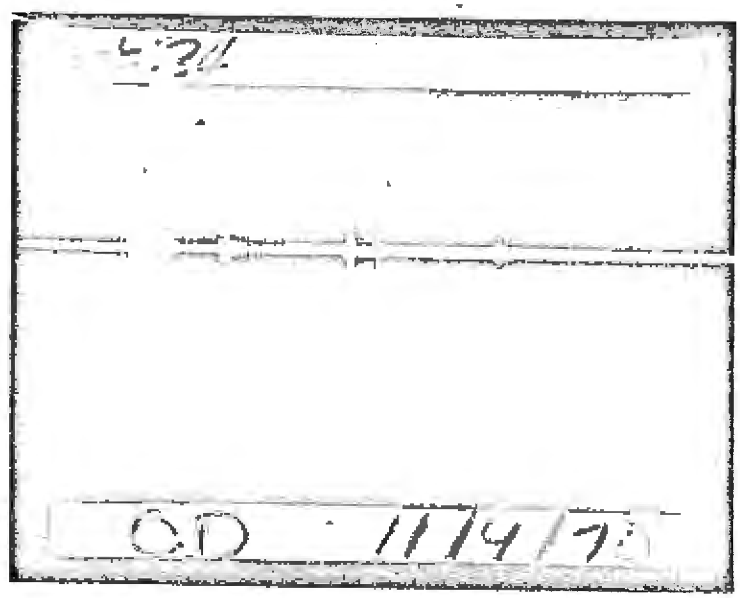
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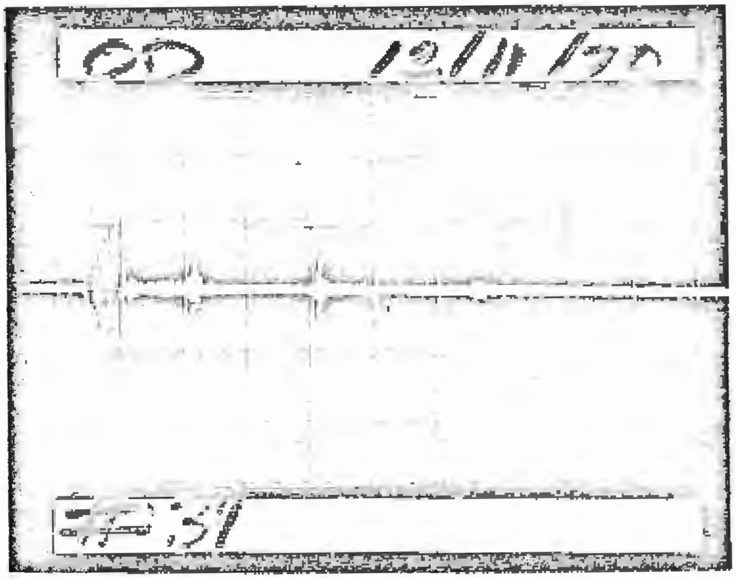
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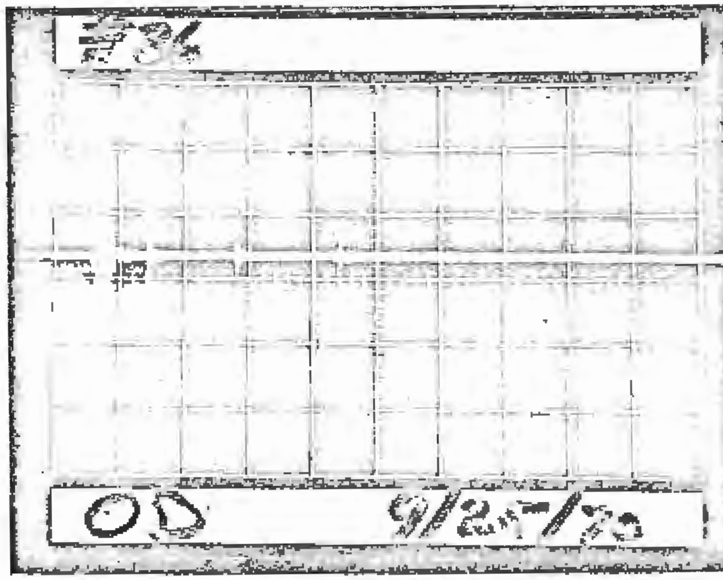
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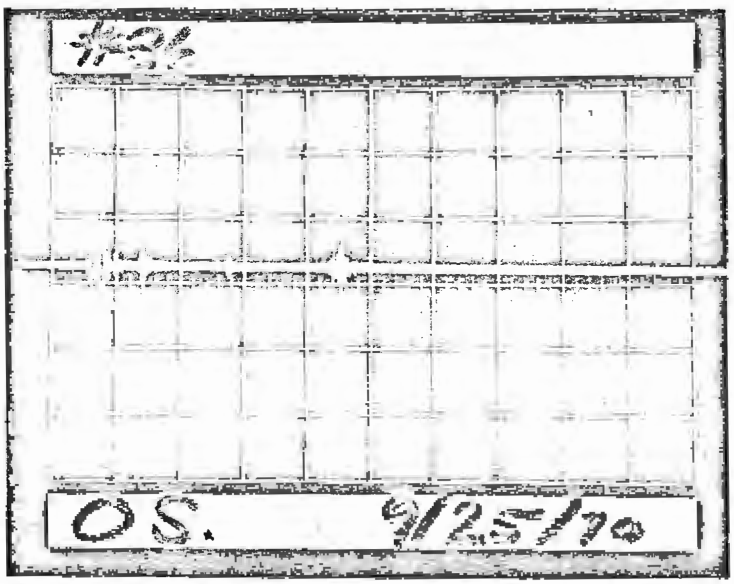
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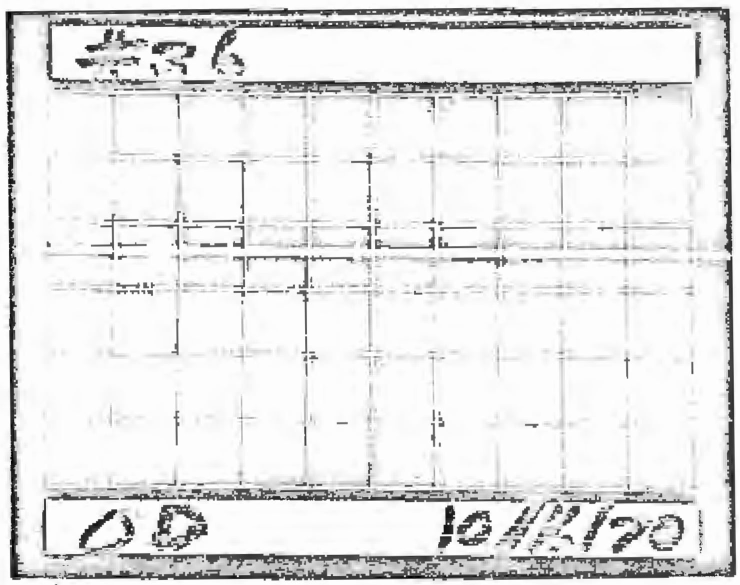
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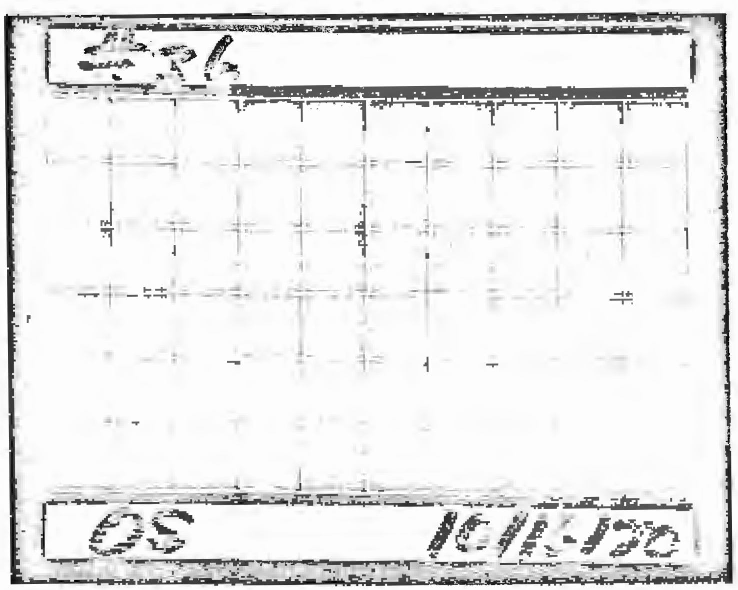
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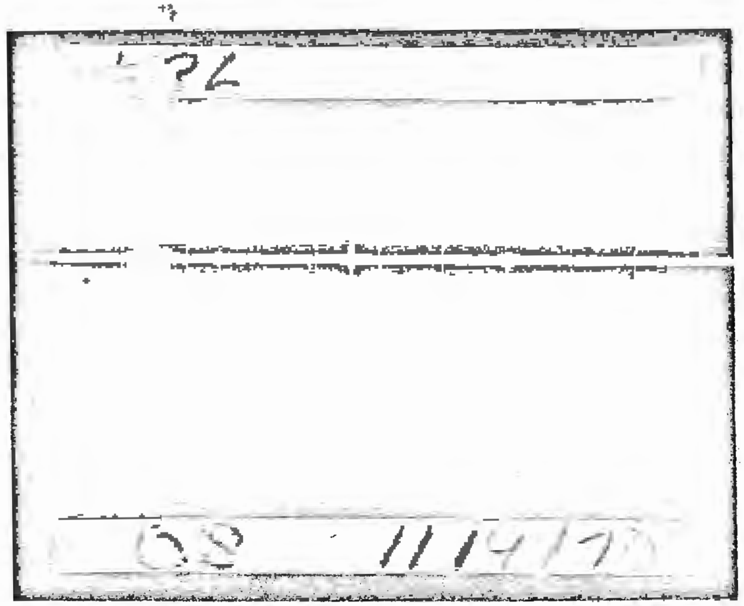
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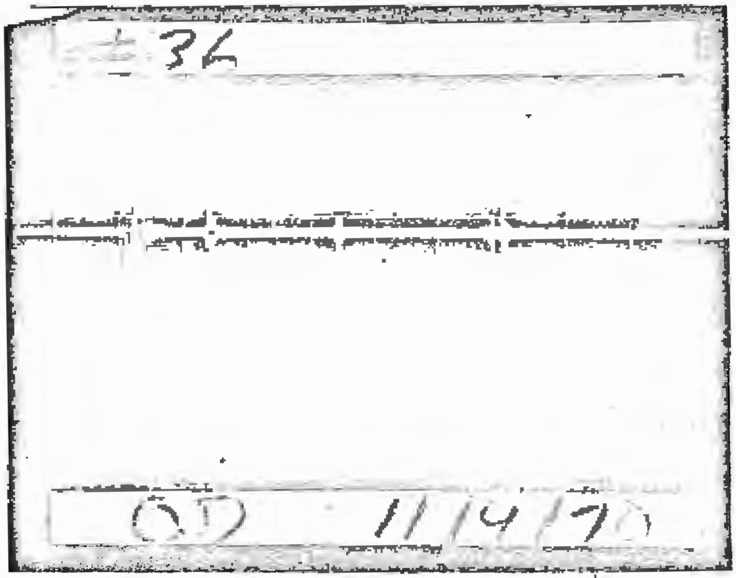
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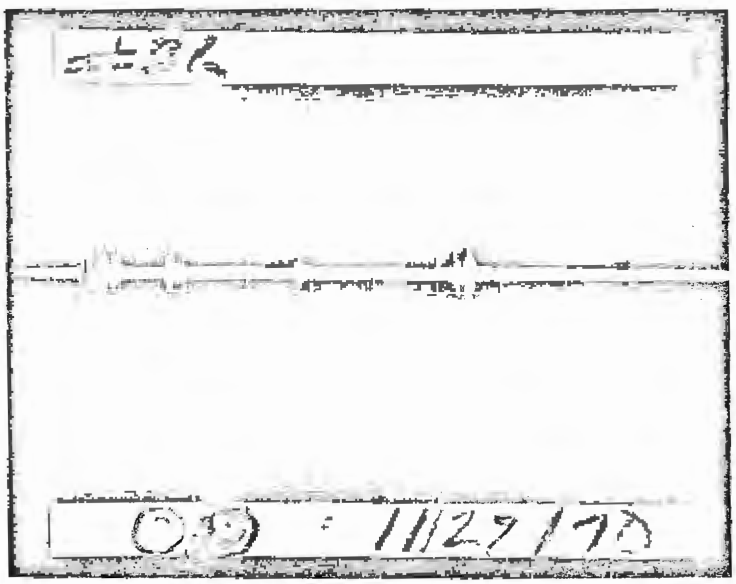
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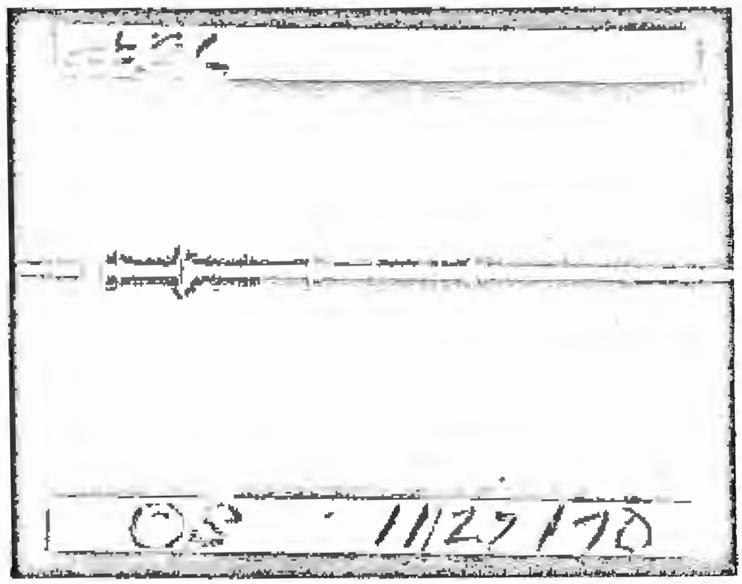
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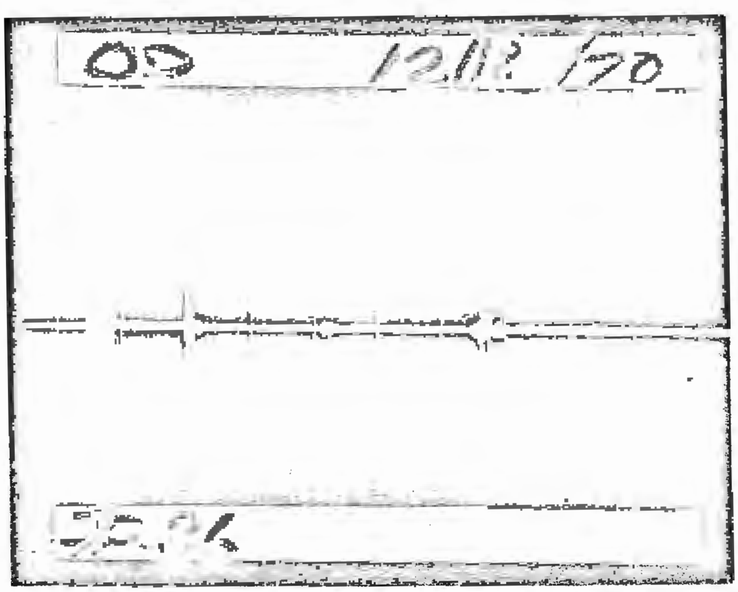
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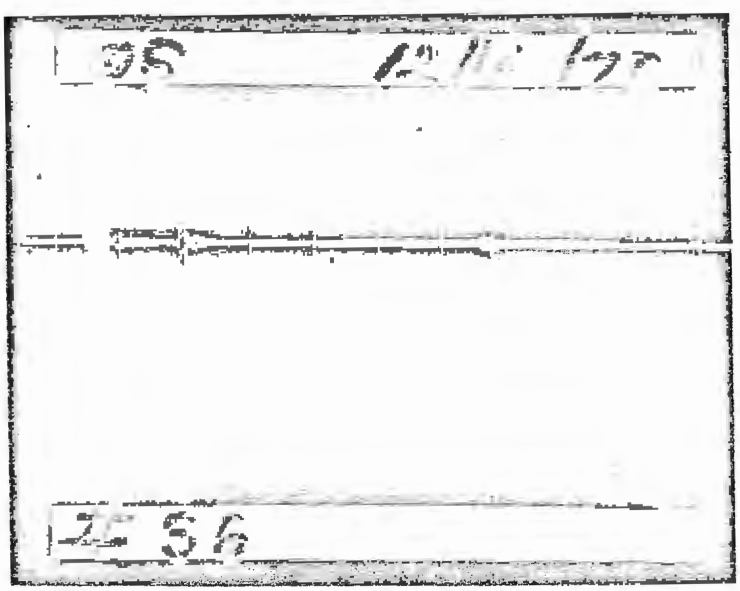
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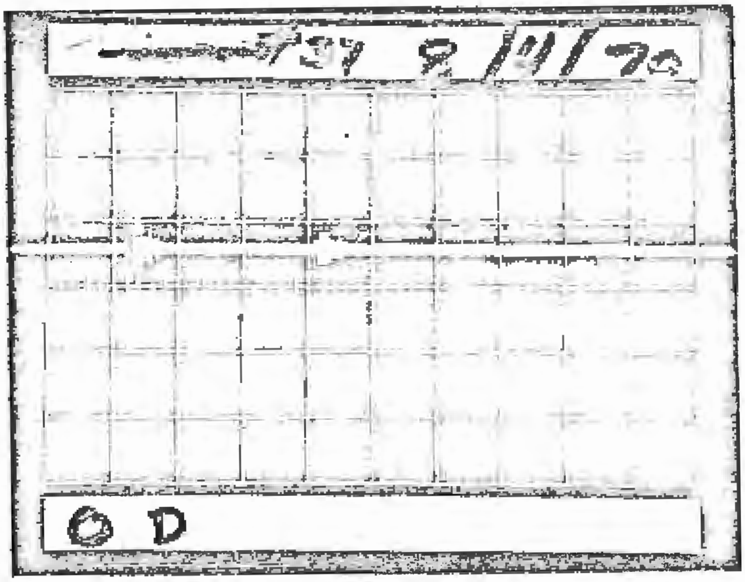
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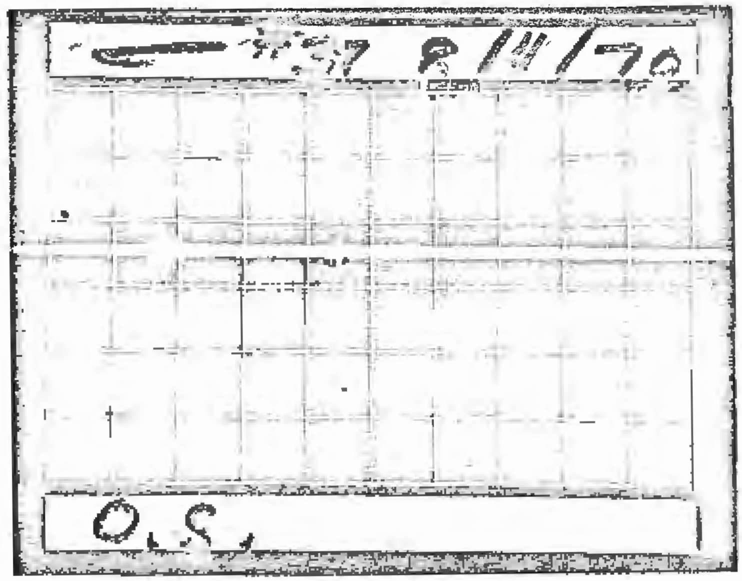
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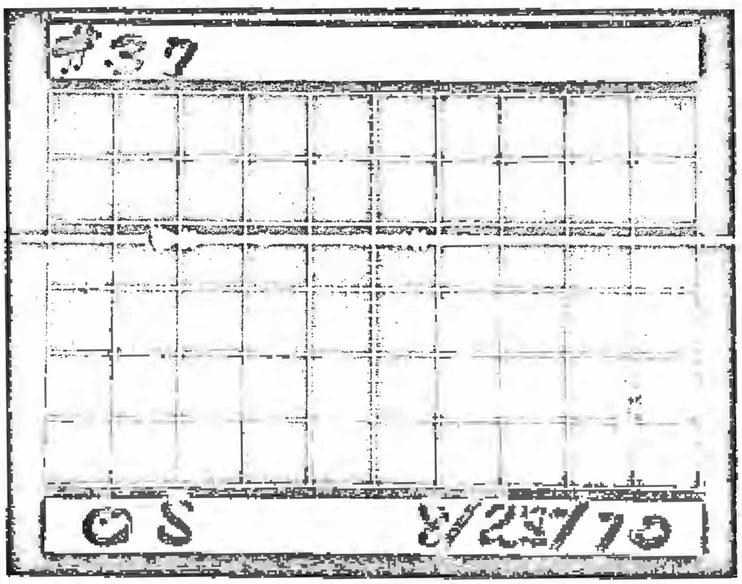
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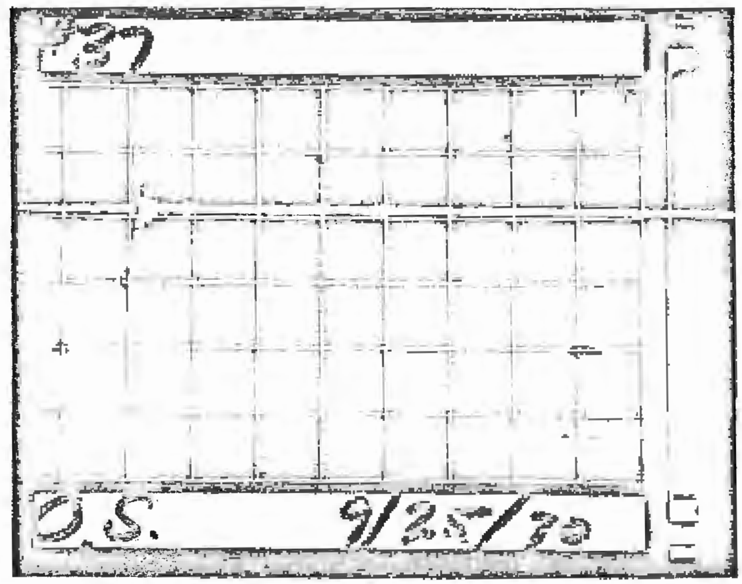
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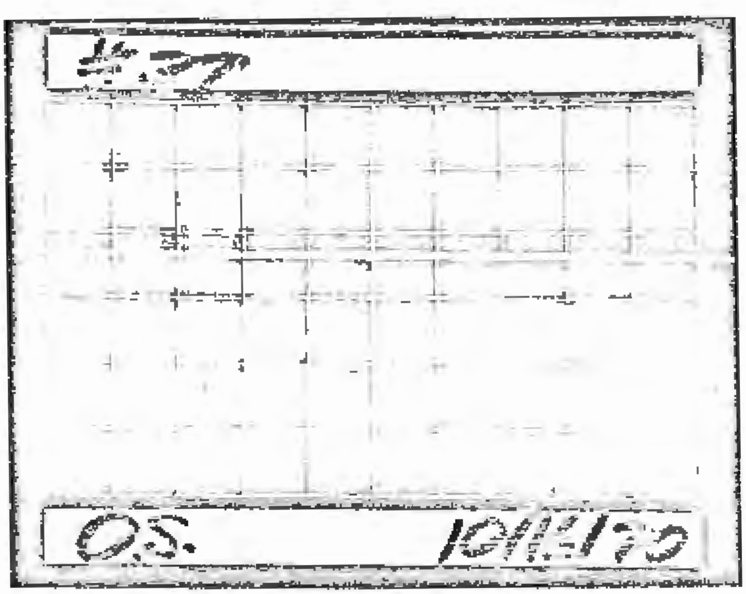
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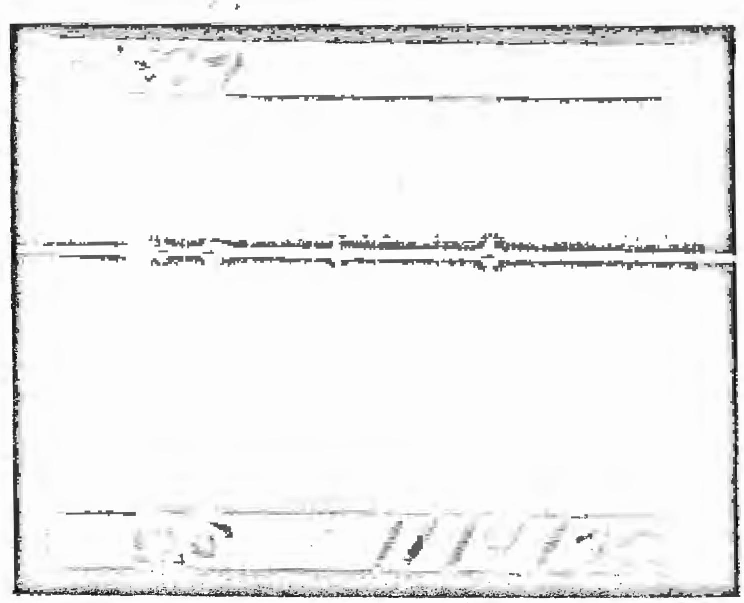

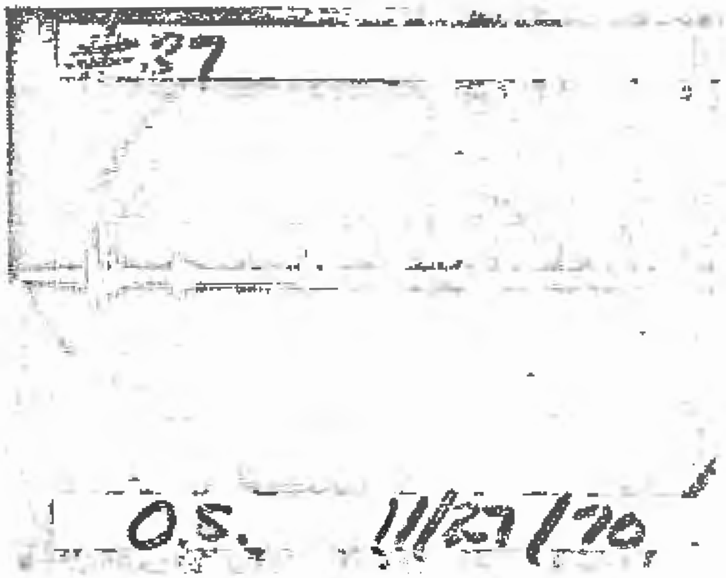
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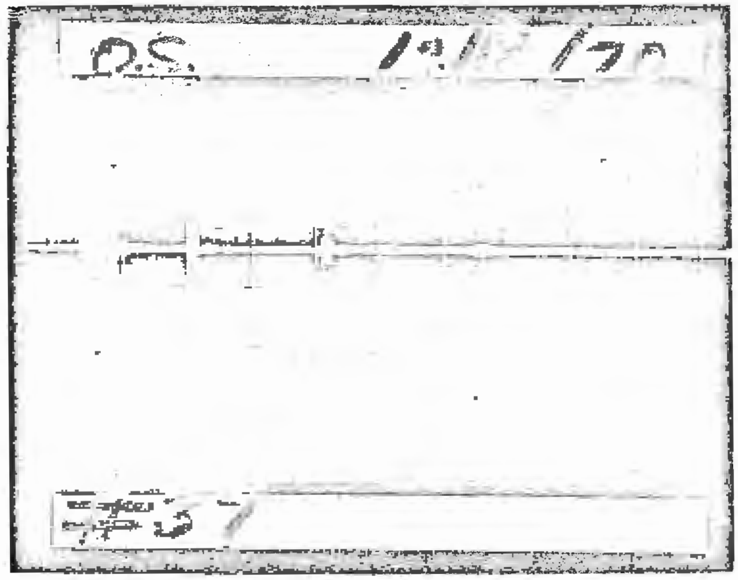
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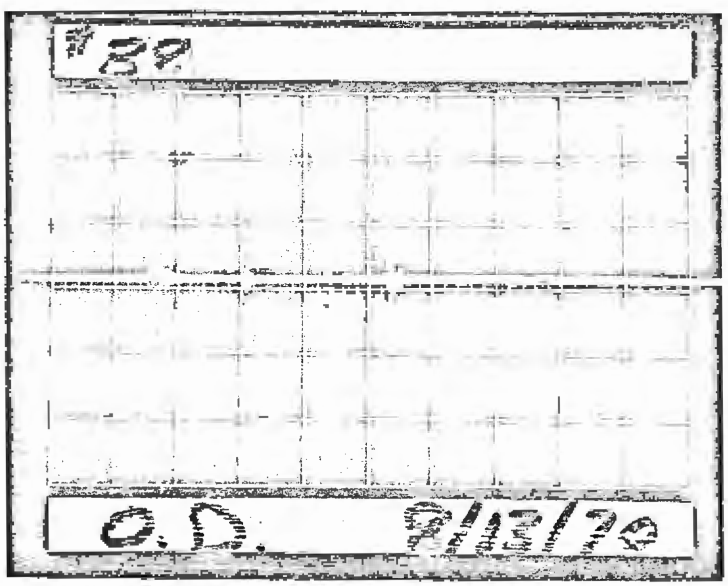
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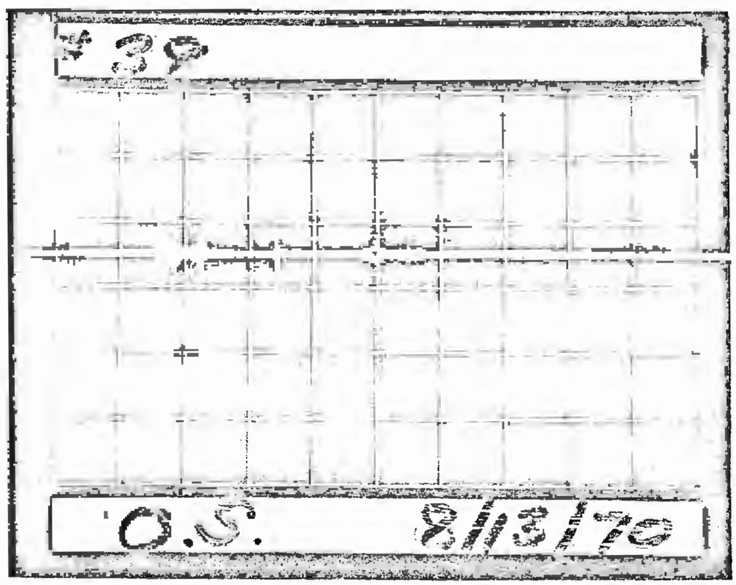
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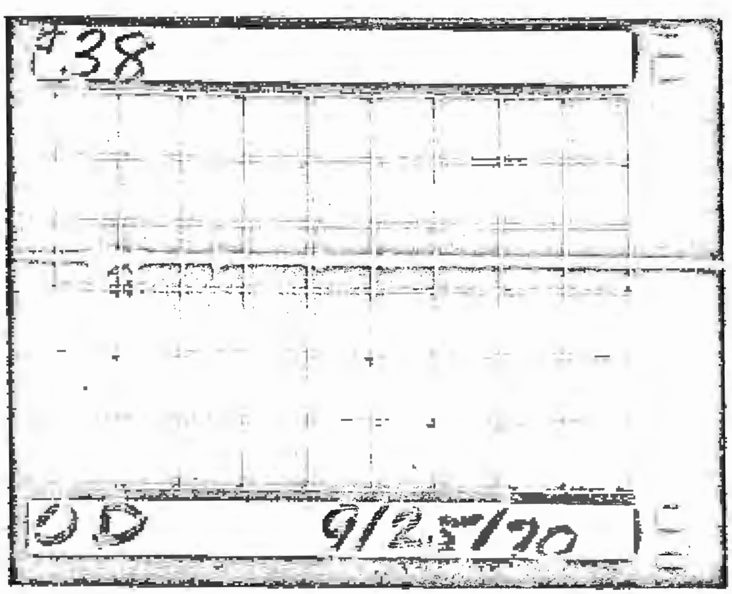
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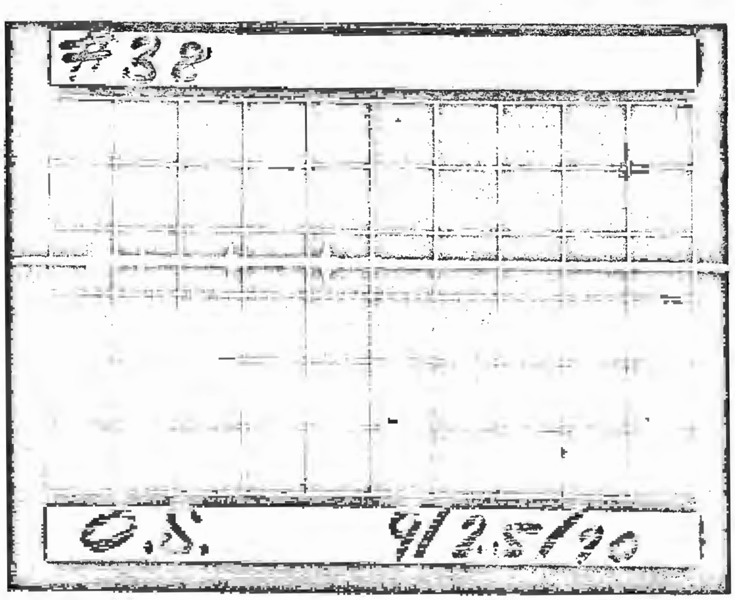
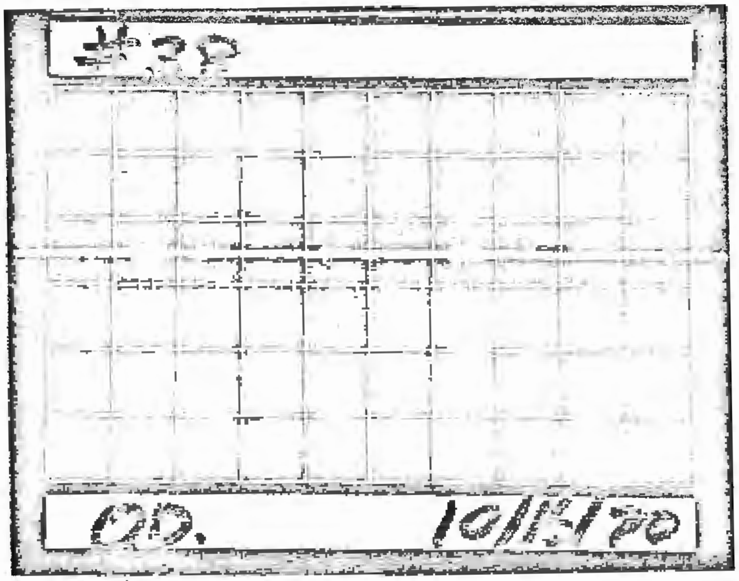
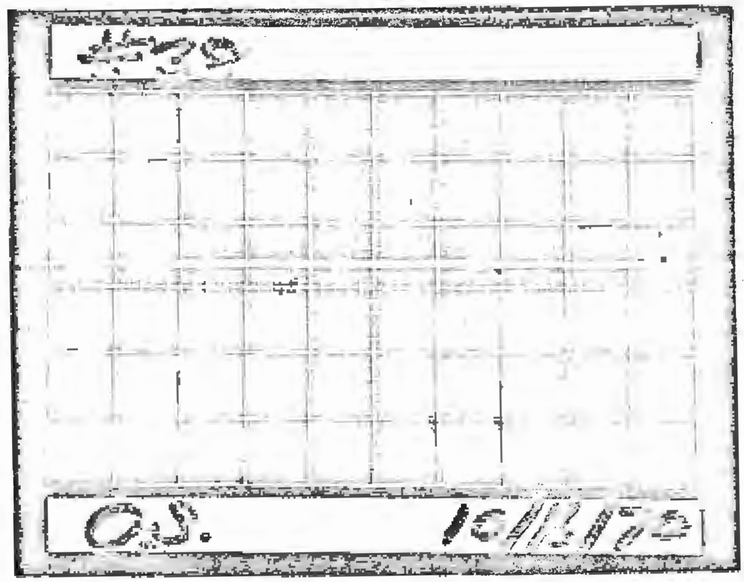
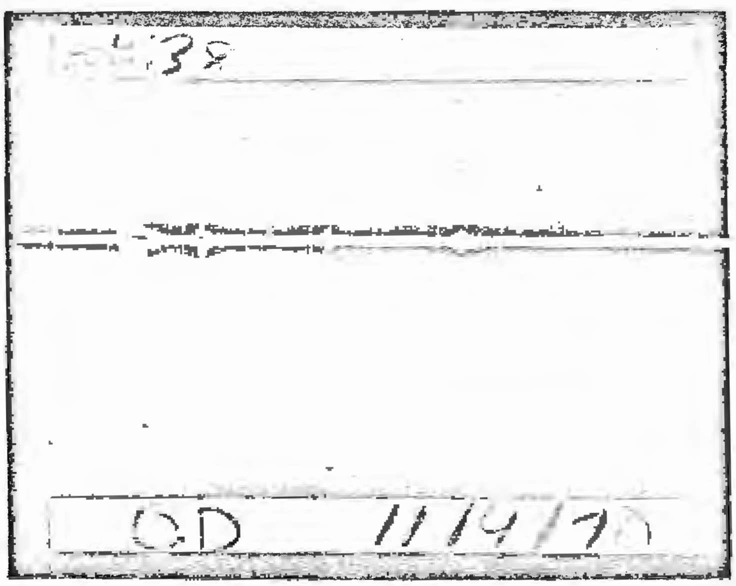
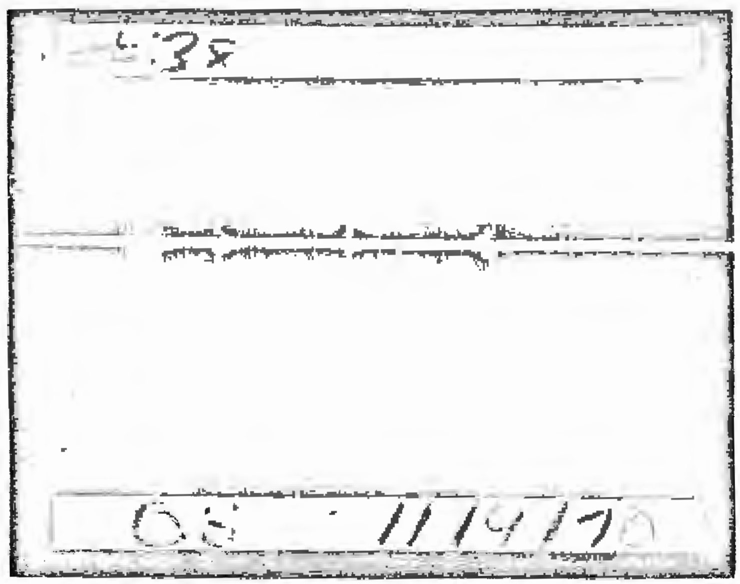
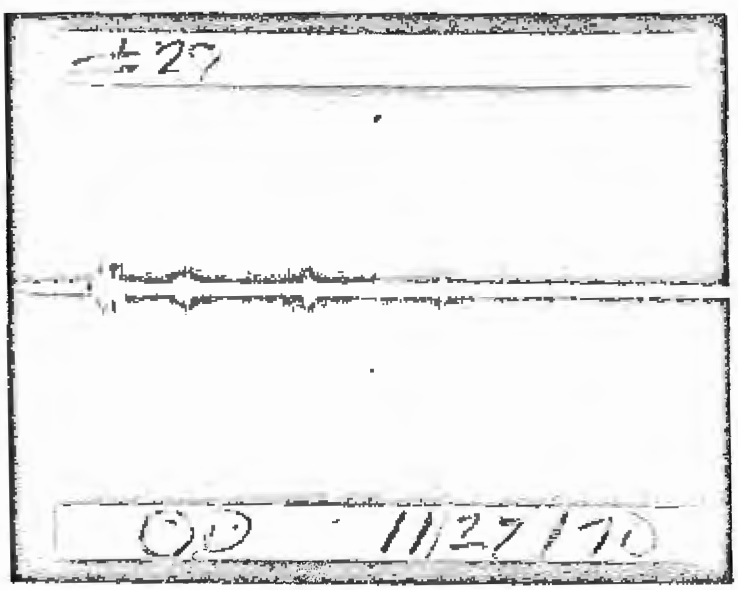

#38
O.S. 9/25/70

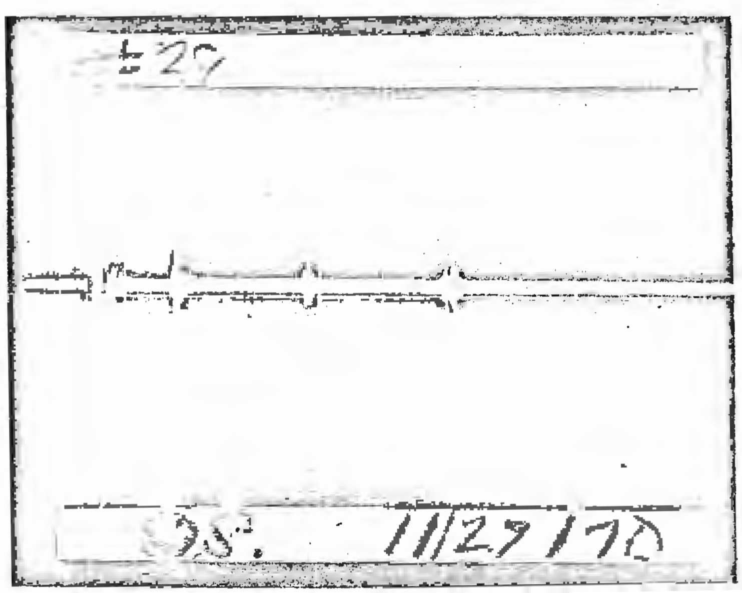

#38
OD. 10/13/70

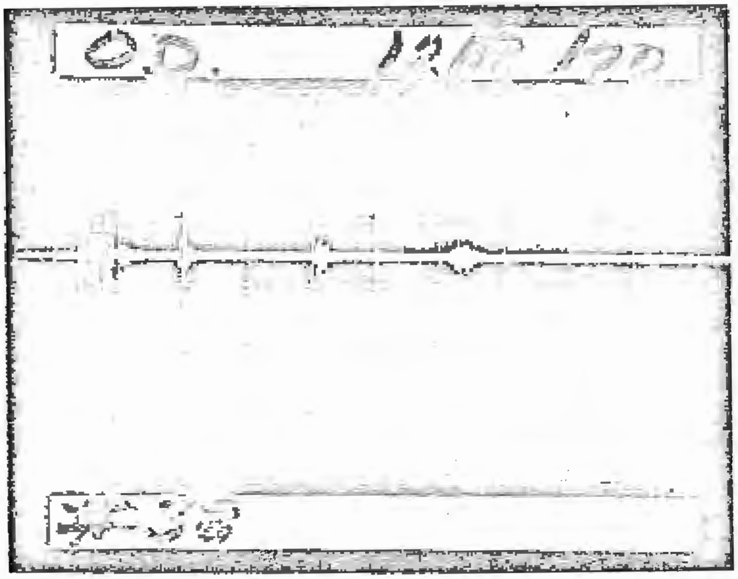

#38
O.S. 10/13/70

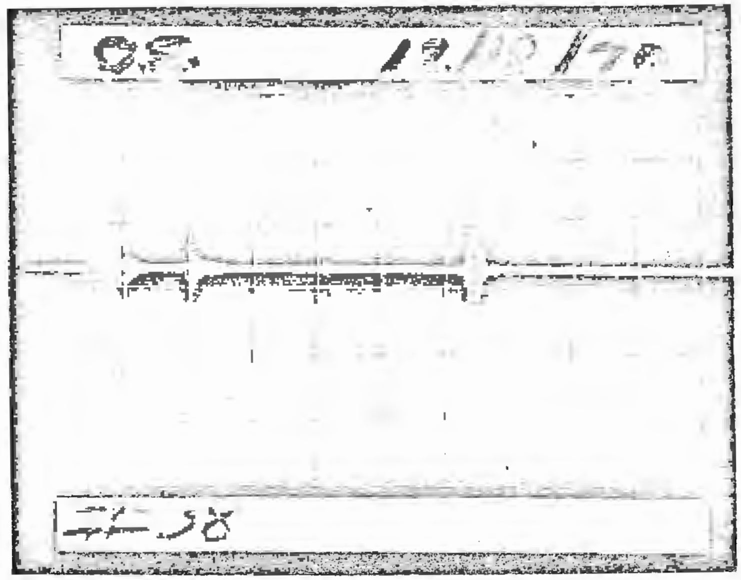

#38
OD 11/4/70

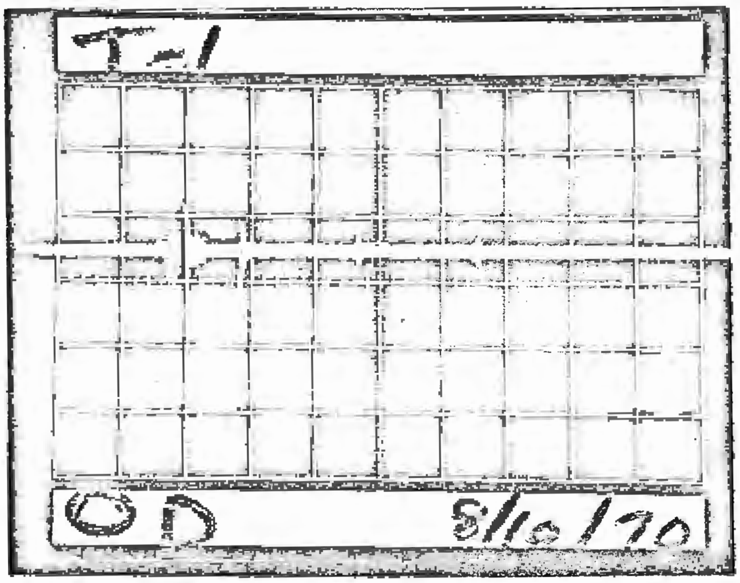

#38
OS 11/4/70

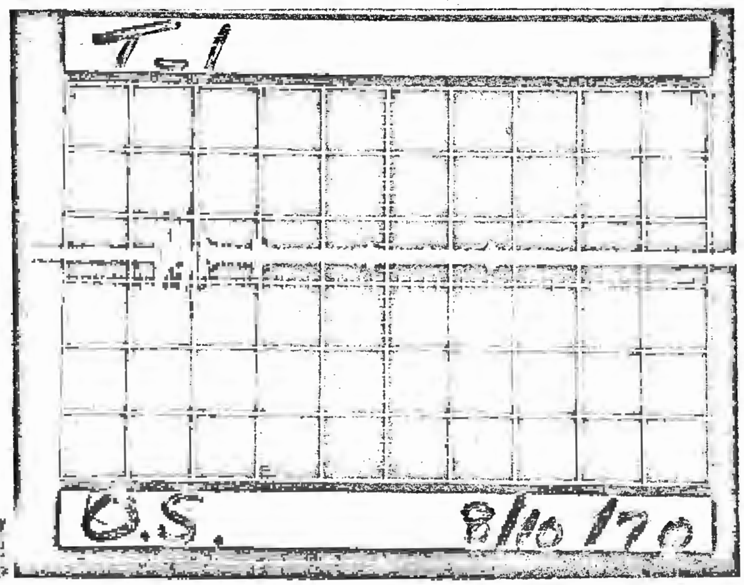

#29
OD 11/27/70

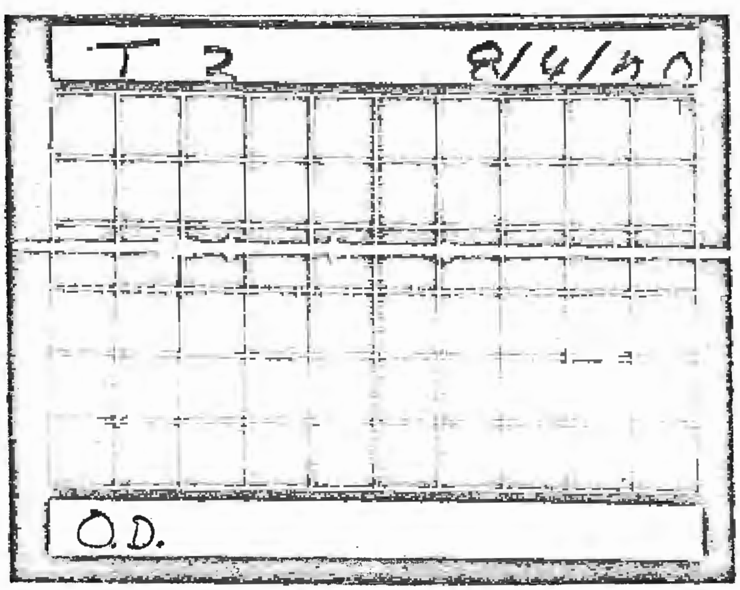

#29
OS. 11/27/70

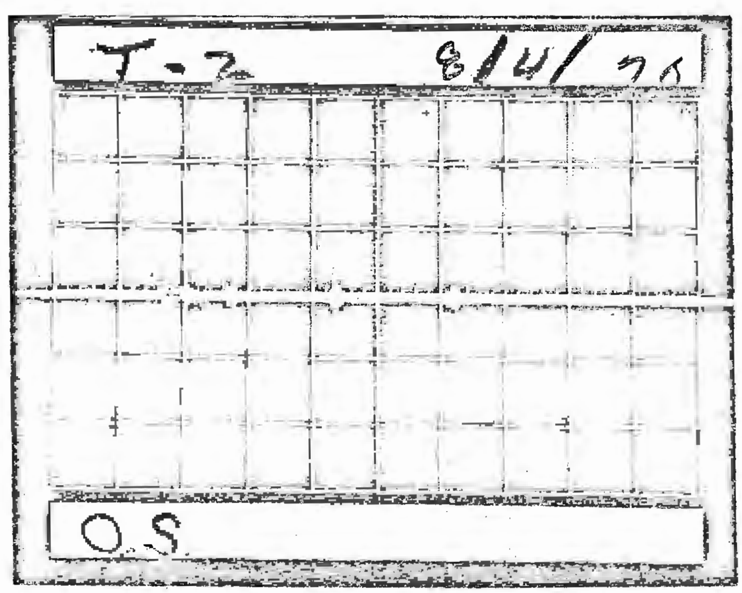

O.D.

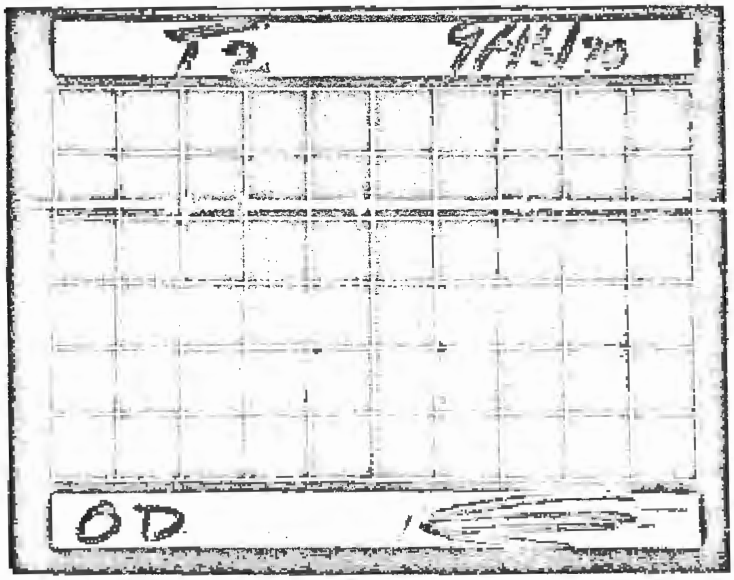

O.S.

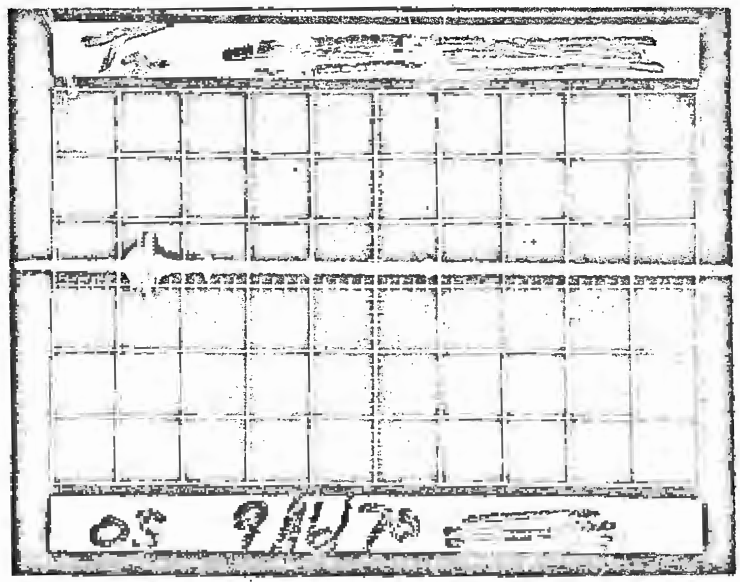

T-1
O.D 8/10/70

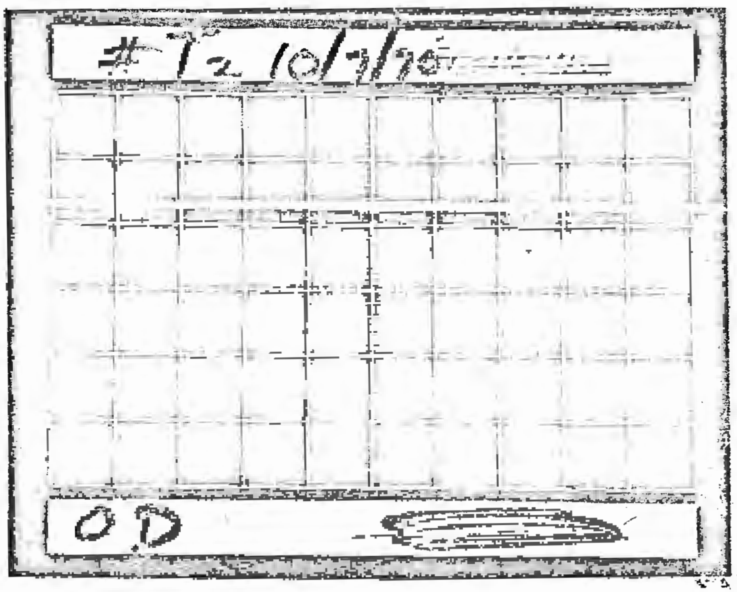

T-1
O.S. 8/10/70

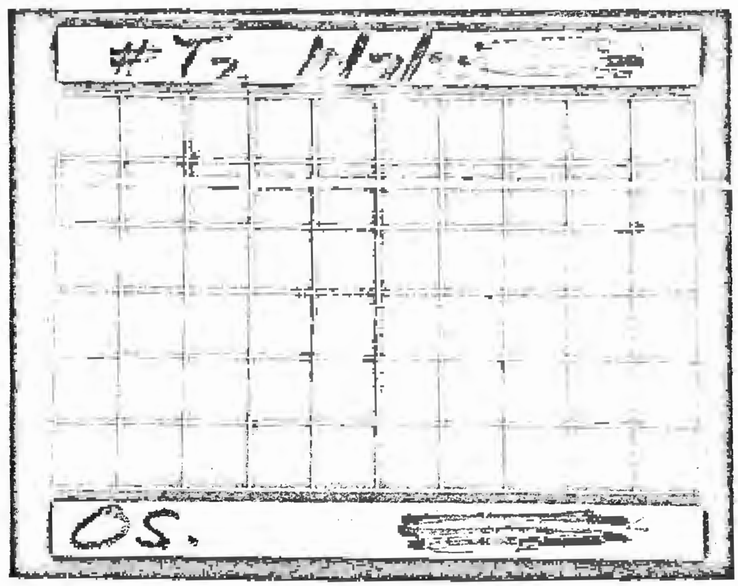

T 2 8/4/70
O.D.


T-2 8/4/70
O.S.


T2 9/13/75
OD

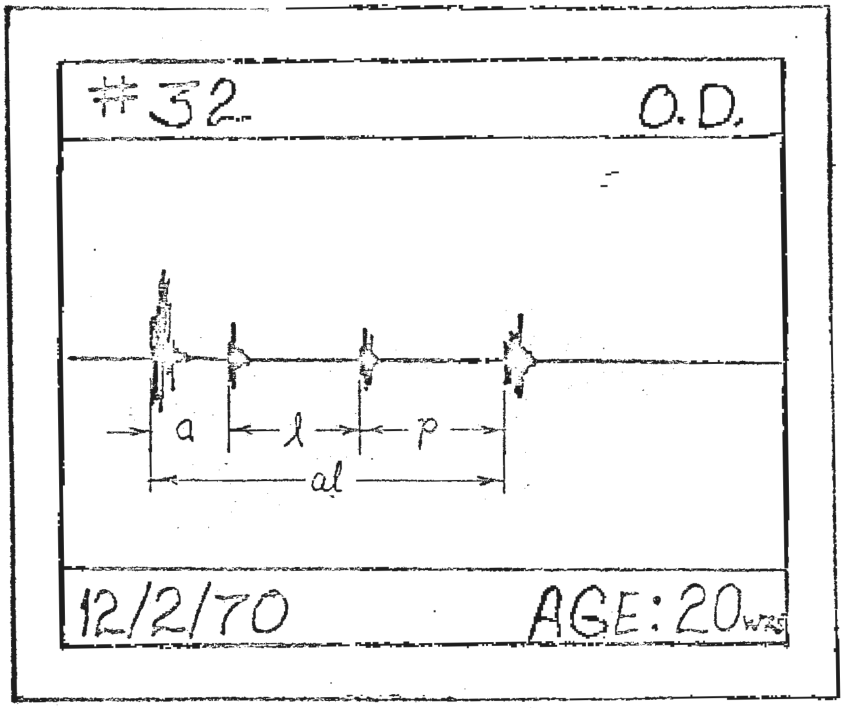

T2
OS 9/16/75


#T2 10/7/75
OD


#T2 11/7/
OS.

TAKING DIMENSIONS FROM THE ULTRASONOGRAM

Anterior



Posterior

Note: Dimensions are measured between the fronts of the respective pulse trains.

1. Symbols: A anterior chamber depth

    L crystalline lens thickness

    P posterior chamber depth

    G length of glass standard

    AL axial length of eye

    a distance on photo corresponding to A

    l " " " " " L

    p " " " " " P

    g " " standard photo corresponding to G

    t_b time base of oscilloscope (sec/cm.)

    t_A time required for the ultrasonic pulse to traverse twice the anterior chamber depth

    t_L time required for the ultrasound pulse to traverse twice the lens thickness

t_P time required for the ultrasonic pulse to traverse twice the posterior chamber depth

t_G time required for the ultrasound pulse to traverse twice the length of the glass standard

v_A velocity of sound in aqueous

v_L " " " " crystalline lens

v_P " " " " vitreous

v_G " " " " glass

2. Formula derivation:

$2A = v_A \times t_A$, i.e., twice the anterior chamber depth equals the velocity of sound in aqueous multiplied by the time required to travel the distance 2A.

but $t_A = t_b \times a$, i.e., traversal time equals oscilloscope time base multiplied by a.

substituting for t_A in the upper equation yields,

(1) $2A = v_A \times t_b \times a$

With respect to the glass standard a similar equation is obtained:

(2) $2G = v_G \times t_b \times g$

Dividing (1) by (2) leads to

$$A = \frac{G \times v_A \times a}{v_G \times g}$$

where all the values on the right side of the equation are either known or can be measured on the photograph.

In like manner L (crystalline lens thickness) and P (posterior chamber depth) can be calculated.

3. Values required for calculations:

$G = 36$ mm, $v_A = v_P = 1543$ m/sec, $v_L = 1641$ m/sec, $v_G = 5500$ m/sec, $g = 27.07$ (obtained from a separate ultrasonogram of the glass standard)

a, l, and p are to be measured in mm directly from the subject's ultrasound pattern photograph.

It should be noted that there is a degree of magnification that takes place because of the lens of the camera, but because both the subject's photograph and the standard's photograph were taken on the same camera, this factor does cancel out, and therefore was not included in the above calculations.

	Initials	Date
Prepared By		
Approved By		

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Cat # & Date	Ant. Cornea A	Ant. Lens B	Post. Lens C	Choroid D	Ant. Chamber B−A	[illegible] C−A [illegible] D−C
OD	#21	7.417	8.380	10.008	11.577		
	9/14/70	7.420	8.382	10.007	11.576		
		7.420	8.380	10.008	11.577	0.962	1.569
		7.419	8.381	10.008	11.577		
OS	#21	7.240	8.194	9.760	11.409		
	9/14/70	7.239	8.197	9.762	11.407		
		7.238	8.196	9.763	11.408	0.956	1.6[illegible]
		7.239	8.195	9.761	11.408		
OD	#28	7.027	7.505	8.563	9.760		
	8/5/70	7.026	7.504	8.564	9.757		
		7.027	7.505	8.563	9.757	0.478	1.195
		7.027	7.505	8.563	9.758		
OS	#28	6.934	7.552	8.564	9.842		
	8/5/70	6.936	7.551	8.563	9.842		
		6.935	7.551	8.562	9.843	0.616	1.280
		6.935	7.551	8.563	9.842		
OD	#32	6.871	8.178	9.426	11.107		
	8/13/70	6.871	8.175	9.427	11.110		
		6.870	8.176	9.429	11.111	1.305	1.006
		6.871	8.176	9.426	11.109		
OS	#32	7.087	8.486	9.784	10.780		
	8/13/70	7.088	8.485	9.786	10.779		
		7.087	8.485	9.785	10.779		
		7.087	8.485	9.785	10.779	1.398	0.99[illegible]
OD	#32	7.184	8.010	9.332	10.771		
	9/14/70	7.185	8.009	9.332	10.772		
		7.185	8.008	9.332	10.771		
		7.185	8.009	9.332	10.771	0.824	1.439
O.S	#32	7.174	8.088	9.406	10.816		
	9/14/70	7.175	8.089	9.404	10.817		
		7.175	8.089	9.405	10.815		
		7.175	8.089	9.405	10.816	0.914	1.41[illegible]
OD	#32	6.947	7.880	9.447	11.302		
	10/2/70	6.946	7.880	9.447	11.303		
		6.947	7.879	9.446	11.301		
		6.947	7.880	9.447	11.302	0.933	1.855
OS.		7.066	8.063	9.602	11.477		
	#32	7.065	8.061	9.603	11.474		
	10/2/70	7.065	8.062	9.602	11.473		
		7.065	8.062	9.602	11.475	0.997	1.87[illegible]

BURROUGHS CORPORATION TODD DIVISION
The Hadley Line Form G580 L REPRODUCIBLE

Kx = [illegible] { Based [illegible] 1.0'

$K_{ap} = 0.37309$ }

(8)	(9)	(10)	(11)	(12)	(13)	(14)
Lens C–B	Ant. Chamber	Posterior Chamber	Lens	Total Length		
1.627	3.5891	5.8538	6.4556	15.8985	OK	
1.546	3.5667	6.1[illegible]	6.2186	15.9251		
1.057	1.7834	4.[illegible]74	4.1979	10.4397	OK	
1.012	2.2[illegible]	4.7718	4.0[illegible]	11.08[illegible]		
1.250	3.8628	3.7533	4.9598	11.5219	OK	
1.300	4.2[illegible]5[illegible]	3.7[illegible]85	4.4581	11.08[illegible]		
1.223	3.0743	5.3[illegible]	5.2[illegible]	1[illegible]	✓	
1.316	2.4100	5.2[illegible]43	5.2216	1[illegible]	✓	
1.567	3.4[illegible]	6.9[illegible]	[illegible]75	16.[illegible]	OK	
1.546	3.7[illegible]	6.9[illegible]	6.1104	1[illegible]		

	Initials	Da
Prepared By		
Approved By		

	(1) Cat # & Date	(2) Ant. Cornea A	(3) Ant. Lens B	(4) Post Lens C	(5) Choroid D	(6) Ant. Chamber B-A	(7) Post. Chamb D-C
	#32	7.006	7.991	9.663	11.363		
OD	10/23/70	7.004	7.990	9.664	11.359		
		7.004	7.990	9.663	11.362		
		7.005	7.990	9.663	11.362	0.985	1.69
	#32	7.026	8.020	9.756	11.572		
OS	10/23/70	7.027	8.022	9.757	11.570		
		7.027	8.021	9.758	11.572		
		7.027	8.021	9.757	11.572	0.994	1.81
	#32	6.983	8.091	9.825	11.756		
OD	11/19/70	6.981	8.090	9.825	11.756		
		6.982	8.099	9.826	11.757		
		6.982	8.090	9.825	11.756	1.108	1.93
	#32	7.095	8.216	9.952	11.839		
OS	11/19/70	7.092	8.217	9.950	11.841		
		7.093	8.215	9.951	11.841		
	#32	7.095	8.216	9.951	11.840	1.121	1.88
	12/2/70	7.062	8.335	10.141	11.950		
OD		7.062	8.332	10.147	11.952		
		7.061	8.332	10.146	11.952		
		7.062	8.333	10.146	11.952	1.271	1.80
	#32	7.065	8.207	9.938	11.848		
OS	12/2/70	7.066	8.207	9.941	11.848		
		7.065	8.206	9.940	11.849		
		7.065	8.207	9.940	11.848	1.142	1.90
OD	#33	7.042	8.340	10.282	12.368		
	10/7/70	7.044	8.342	10.280	12.372		
		7.041	8.339	10.283	12.370		
		7.043	8.340	10.282	12.370	1.297	2.088
	#33	7.013	7.885	9.518	11.600		
OS	10/7/70	7.011	7.884	9.519	11.604		
		7.010	7.885	9.518	11.602		
		7.012	7.885	9.518	11.602	0.873	2.0
	#34	7.070	8.287	9.527	12.127		
OD	8/6/70	7.074	8.286	9.525	12.125		
		7.067	8.287	9.522	12.126		
		7.070	8.287	9.527	12.126	1.217	2.59
		7.110	8.470	9.669	12.219		
	#34	7.113	8.469	9.667	12.220		
OS	8/6/70	7.110	8.472	9.668	12.218		
		7.111	8.470	9.668	12.219	1.359	2.55

(8)	(9)	(10)	(11)	(12)	(13)	(14)
LENS C-B	ANT. CHAMBER	POST. CHAMBER	LENS	TOTAL LENGTH		
1.673	3.6749	6.3788	6.6381	16.6518		
					OK	
1.736	3.7085	6.7716	6.8881	17.3492		
1.735	4.1378	7.2044	6.8841	12.2222		
					OK	
1.735	4.1823	7.0417	6.8841	12.1141		
1.813	4.7420	6.7350	7.1936	12.6796		
					OK	
1.733	4.2607	7.1186	6.8762	12.2555		
1.942	4.9380	7.7901	7.7055	12.0334		
					OK d.h.L	
1.622	3.2571	7.7152	6.4797	12.5117		
1.240	4.5405	9.6946	4.9801	10.5547		
					OK	
1.198	5.0703	3.5105	4.7534	10.3412		

	Initials	Date
Prepared By		
Approved By		

BURROUGHS CORPORATION TODD DIVISION — The Hadley Line Form G580 REPRODUCIBLE

		(1) Cat # & Date	(2) Ant. Corner A	(3) Ant. Lens B	(4) Post. Lens C	(5) Choroid D	(6) Ant. Chamber [illegible] - B - A	(7) Posterior Chamber D - C
	1	#34	7.291	8.556	9.817	12.345		
	2	8/6/70	7.292	8.557	9.817	12.341		
OD	3		7.293	8.556	9.817	12.344		
	4		7.293	8.55[illegible]	9.817	12.345	1.263	2.52[illegible]
	5		7.100	8.318	9.684	12.168	7.293	7.456
	6	#34	7.099	8.316	9.682	12.167	.1630	1.240
OS	7	8/[illegible]/70	7.101	8.318	9.684	12.167		
	8		7.100	8.316	9.684	12.167	1.218	2.483
	9	#34	7.119	8.794	10.105	12.373	7.100	7.321
	10	9/18/70	7.119	8.791	10.104	12.375	.227	1.222
OD	11		7.119	8.794	10.105	12.372		
	12		7.119	8.793	10.105	12.373	1.674	2.268
	13	#34	7.120	8.055	9.659	11.579	7.119	7.697
	14	10/7/70	7.121	8.055	9.658	11.578	.578	1.315
OD	15		7.122	8.055	9.659	11.579		
	16	#34	7.121	8.055	9.659	11.579	2.937	1.920
	17	10/30/70	7.140	8.076	9.683	11.656		
	18		7.138	8.077	9.685	11.655		
OD	19		7.139	8.078	9.691	11.655		
	20		7.139	8.077	9.673	11.655		
	21		7.038	8.123	9.713	11.690	1.085	1.97[illegible]
	22	#34	7.034	8.123	9.715	11.690		
	23	10/20/70	7.033	8.124	9.712	11.690		
OD	24		7.036	8.123	9.713	11.690	1.087	1.977
	25		7.060	8.265	9.910	11.887		
	26	#34	7.058	8.260	9.908	11.887		
OD	27	11/9/70	7.061	8.260	9.909	11.887		
	28		7.060	8.261	9.909	11.887	1.201	1.978
	29	#34	7.057	8.472	10.108	12.204		
	30	12/11/70	7.056	8.476	10.108	12.205		
OD	31		7.057	8.471	10.108	12.205		
	32		7.057	8.471	10.108	12.207	1.414	2.0[illegible]
	33	#36	7.08[illegible]	8.447	9.615	11.593		
	34	8/13/70	7.085	8.447	9.615	11.592		
OD	35		7.085	8.448	9.614	11.592		
	36		7.085	8.447	9.615	11.592	1.362	1.977
	37	#36	7.092	8.426	9.745	11.923	[illegible]	2.1[illegible]
QUALI OS	38	8/13/70	7.093	8.425	9.746	11.9[illegible]	.333	1.1[illegible]5
	39		7.092	8.426	9.745	11.930		
	40		7.092	8.426	9.745	11.930	1.334	1.835
							7.[illegible]	7.455

(8)	(9)	(10)	(11)	(12)	(13)	(14)
LENS C-B	ANT. CHAMBER	POST. CHAMBER	LENS	TOTAL LENGTH		
1.261	.47121	9.4243	.50084	13.05[illegible]		
8.918 9.65[illegible]						
.9620	2.6081	4.6263	.38170	13.0514	✓ OK	
1.366	4.5442	9.2637	.52300	~~1[illegible]~~		
8.456 9.6[illegible]						
1.129						
1.312	.62455	.84617	.52052	15.9130	✓ OK	
8.7[illegible] 10.[illegible]						
1.093						
1.604	3.4817	21.633	.63844	17.0124	✓ OK	
1.590	4.0450	7.3760	.62058	17.7328	OK	
1.590	4.0555	.73760	.63088	177[illegible]	OK	
1.648	4.4989	7.3787	.65389	12.3[illegible]	OK	
1.637	5.2155	7.8312	.64953	19.0020	OK	
1.168	.50215	.73760	.4[illegible]	~~1.[illegible]~~		
[illegible] 9.445						
1.030	1.2410	4.731	.4030	10.7689		
1.819	4.9770	6.8462	.52335	~~4.7046~~		
5.454 [illegible]						

	Initials	Date
Prepared By		
Approved By		

		(1) Cornea Date	(2) Ant. Cornea A	(3) Ant Lens B	(4) Post. Lens C	(5) Choroid D	(6) Ant. Chamber B-A	(7) Post. Chamber D-C
	1	#36	7.042	7.766	8.920	10.230		
	2	9/25/70	7.043	7.764	8.920	10.229		
OD	3		7.044	7.767	8.920	10.230		
	4		7.043	7.765	8.920	10.230	0.723	1.310
	5	#35	7.012	7.680	8.843	10.224		
	6	9/25/70	7.006	7.680	8.842	10.225		
OS	7		7.010	7.680	8.843	10.223		
	8		7.010	7.680	8.843	10.224	0.670	1.381
	9	#36	7.052	8.112	9.791	11.843		
	10	10/16/70	7.053	8.112	9.788	11.840		
OD	11		7.054	8.112	9.789	11.846		
	12		7.053	8.112	9.789	11.843	1.059	2.054
	13	#36	7.054	8.109	9.750	11.704		
OS	14	10/16/70	7.053	8.111	9.745	11.702		
	15		7.054	8.110	9.752	11.702		
	16		7.054	8.110	9.749	11.703	1.056	1.954
C	17	#36	7.060	8.208	9.937	11.949		
	18	11/9/70	7.058	8.209	9.938	11.946		
OS	19		7.058	8.211	9.937	11.948		
	20		7.059	8.209	9.937	11.948	1.150	2.01[illegible]
	21	#36	7.022	8.102	9.202	11.820		
	22	11/9/70	7.021	8.102	9.205	11.821		
OD	23		7.022	8.101	9.204	11.818		
	24		7.022	8.102	9.204	11.819	1.080	2.015
	25	#36	7.039	8.164	9.886	11.957		
OD	26	11/27/70	7.037	8.164	9.885	11.953		
	27		7.038	8.163	9.885	11.955		
	28		7.038	8.164	9.885	11.955	1.126	2.070
	29		7.042	8.298	10.055	12.112		
OS	30	#36	7.043	8.298	10.055	12.111		
	31	11/27/70	7.042	8.299	10.055	12.114		
	32		7.042	8.298	10.055	12.112	1.256	2.057
	33	#36	7.052	8.357	10.154	12.166		
OD	34	12/11/70	7.052	8.356	10.156	12.165		
	35		7.052	8.356	10.155	12.164		
	36		7.052	8.356	10.155	12.165	1.304	2.010
	37	#36	7.039	8.250	10.148	12.194		
OS	38	12/11/70	7.038	8.252	10.146	12.191		
	39		7.038	8.250	10.146	12.192		
	40		7.038	8.251	10.146	12.192	1.213	2.046

(8)	(9)	(10)	(11)	(12)	(13)	(14)
LENS C-B	ANT. CHAMBER	POST CHAMBER	LENS	TOTAL AXIAL LENGTH		
1.157	4.6974	5.8875	5.5788	15.2637		
					OK	
1.163	4.4997	5.1529	5.6116	15.2657		
1.677	3.9510	7.6633	6.6540	18.2683		
					OK	
1.639	3.9398	7.2902	6.5032	17.7332		
1.721	4.2905	7.5028	6.8564	18.6497		
					OK	
1.702	4.0294	7.5178	6.7532	18.3004		
1.721	4.2010	7.7230	6.8286	18.7526		
					OK	
1.757	4.6860	7.6745	6.9714	19.3319		
1.799	4.8657	7.[illegible]	7.1331	19.5023		
					OK	
1.895	4.5256	7.6330	7.5[illegible]	19.[illegible]		

	Initials	Date
Prepared By		
Approved By		

		(1)	(2)	(3)	(4)	(5)	(6)	(7)
		Cat # & Date	Ant. Corner A	Ant. Lens B	Post. Lens C	Chord D	Ant. Chamber B-A	Post Chamber D-C
	1	#37	7.042	8.195	9.500	11.075		
	2		7.041	8.195	9.500	11.075		
OD	3	8/4/70	7.042	8.195	9.501	11.075		
	4		7.042	8.195	9.500	11.075	1.153	1.575
	5		7.040	8.270	9.454	11.101		
	6	#37	7.040	8.274	9.453	11.099		
OS	7	8/4/70	7.039	8.271	9.453	11.100		
	8	#37	7.040	8.272	9.453	11.100	1.032	1.647
	9	8/24/70	7.005	8.425	9.742	10.806		
	10		7.005	8.423	9.743	10.805		
OS	11		7.005	8.422	9.743	10.807		
	12		7.005	8.423	9.743	10.806	1.418	0.863
	13	#37	7.016	8.498	9.702	10.632		
	14	8/25/70	7.016	8.498	9.701	10.634		
OS	15		7.016	8.498	9.702	10.633		
	16		7.016	[illegible]	9.703	10.633	1.483	[illegible]
C	17	#37	7.022	8.825	10.166	11.609		
	18	9/25/70	7.023	8.826	10.168	11.609		
OS	19		7.022	8.825	10.167	[illegible]		
	20		7.022	8.825	10.167	11.609	1.803	1.442
	21	#37	7.046	8.047	9.703	11.578		
	22	10/14/70	7.044	8.048	9.703	11.579		
OS	23		7.045	8.047	9.703	11.580		
	24		7.045	8.047	9.703	11.579	1.002	1.876
	25	#37	7.017	8.032	9.752	11.678		
	26	11/[illegible]/70	7.017	8.032	9.755	11.676		
OS	27		7.017	8.032	9.754	[illegible]		
	28		7.017	8.032	9.754	[illegible]	1.015	[illegible]
	29	#37	7.044	8.289	9.981	11.937		
	30	11/24/70	7.047	8.288	9.978	11.937		
OS	31		7.047	8.289	9.980	11.937		
	32		7.046	8.289	9.980	11.937	1.243	1.957
	33	#37	7.032	8.432	10.180	12.203		
	34	12/15/70	7.032	8.432	10.178	12.201		
OS	35		7.032	8.431	10.179	12.202		
	36		7.032	8.433	10.179	12.202	1.401	[illegible]
	37	#37	7.045	7.762	8.854	10.159		
OD	38	8/13/70	7.044	7.763	8.855	10.159		
	39		7.046	7.762	8.854	10.159		
	40		7.045	7.763	8.854	10.159	0.719	[illegible]

(8)	(9)	(10)	(11)	(12)	(13)	(14)
LENS C-B	ANT. CHAMBER	VITR. CHAMBER	LENS	TOTAL AXIAL LENGTH		
1.305	3.3017	3.8762	5.1780	11.3559	70%	
1.181	3.5945	3.1448	5.2840	11.2473		
1.320	5.2004	3.2198	5.2375	13.7477		
1.305	5.5292	3.9036	5.1780	15.2038		
1.342	4.7262	5.3800	5.3248	17.4316		
1.656	3.7384	4.9992	6.5707	17.3025		
1.722	3.7859	7.708	4.8326	17.7903		
1.691	4.6375	7.3044	6.7095	18.6424		
1.725	5.7750	4.8044	4.9218	1[illegible]		
1.071	2.6788	3.7942	5.2435	11.7735		

	Initials	Date
Prepared By		
Approved By		

		(1)	(2)	(3)	(4)	(5)	(6)	(7)
		Contact Date	Ant. Cornea A	Ant. Lens B	Post. Lens C	Chord D	Ant. Chamber B-A	Post Chamber D-C
	1	#38	7.038	7.895	8.900	10.100		
	2	8/13/70	7.037	7.895	8.900	10.101		
OS	3		7.037	7.895	8.900	10.101		
	4		7.037	7.895	8.900	10.101	0.858	1.201
	5	#38	7.065	7.638	8.752	13.102		
	6	9/25/70	7.065	7.637	8.750	13.102		
OD	7		7.066	7.638	8.750	13.102		
	8		7.065	7.638	8.750	13.102	0.573	1.352
	9	#38	7.039	7.714	8.875	13.106		
	10	9/25/70	7.039	7.716	8.874	13.104		
OS	11		7.039	7.715	8.874	13.105		
	12		7.039	7.715	8.874	13.105	0.676	1.231
	13	#38	7.039	7.907	9.580	11.273		
	14	10/15/70	7.038	7.906	9.580	11.272		
OD	15		7.040	7.908	9.580	11.272		
	16		7.0[illegible]	7.907	9.580	11.272	0.868	1.692
	17	#38	7.037	7.988	9.707	11.376		
OS	18	10/16/70	7.036	7.985	9.704	11.374		
	19		7.036	7.986	9.704	11.374		
	20		7.037	7.986	9.705	11.375	0.949	1.670
	21	#38	7.039	7.990	9.671	11.386		
OD	22	11/9/70	7.040	7.989	9.672	11.387		
	23		7.043	7.989	9.673	11.386		
	24		7.041	7.989	9.672	11.386	0.948	1.714
	25	#38	7.036	8.159	9.887	11.619		
OS	26	11/9/70	7.036	8.157	9.888	11.620		
	27		7.036	8.159	9.888	11.621		
	28		7.036	8.159	9.888	11.620	1.023	1.732
	29	#38	7.040	8.223	9.929	11.773		
OD	30	11/27/70	7.038	8.223	9.927	11.772		
	31		7.038	8.222	9.927	11.771		
	32		7.039	8.223	9.928	11.773	1.184	1.845
	33	#38	7.038	8.155	9.891	11.718		
	34	11/27/70	7.037	8.155	9.890	11.718		
OS	35		7.039	8.155	9.892	11.718		
	36		7.038	8.155	9.891	11.718	1.117	1.827
	37	#38	7.038	8.344	10.132	11.922		
OD	38	12/18/70	7.039	8.344	10.135	11.919		
	39		7.039	8.344	10.135	11.921		
	40		7.039	8.344	10.134	11.921	1.305	1.787

(8) Lens C-B	(9) Ant. Chamber	(10) Vitr. Chamber	(11) Lens	(12) Total Axial Length	(13)	(14)
1.005	3.2011	3.450[illegible]	5.2876	11.6395		
1.112	3.3378	6.0442	5.4122	14.5342		
1.159	3.5211	5.5927	5.5587	14.7155		
1.673	3.2384	6.3187	4.6281	16.1892		
1.719	3.5406	6.2806	6.8206	16.5918		
1.683	3.5369	6.3948	6.4778	16.6095		
1.729	3.5117	6.4619	6.8603	17.1389		
1.705	4.4174	6.4855	6.7451	18.0430	ok	
1.736	4.1674	6.8147	[illegible]	17.[illegible]		
1.790	4.8188	6.6671	7.1024	18.6753	ok	

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	Initials	Date
Prepared By		
Approved By		

		(1) Camera Date	(2) Ant. Cornea A	(3) Ant. Lens B	(4) Post. Lens C	(5) Choroid D	(6) Ant. Chamber B-A	(7) Post. Chamber D-C
	1	#38	7.230	8.340	10.153	11.958		
	2	12/11/70	7.029	8.340	10.152	11.957		
05.	3		7.030	8.340	10.153	11.957		
	4		7.030	8.340	10.153	11.9[illegible]	1.310	1.804
	5	#39	7.048	7.4[illegible]	8.374	9.520	10.171	
	6	8/13/70	7.047	7.4[illegible]	8.375	9.519		
08	7		7.048	[illegible]	8.375	9.520	0.390	1.145
	8		7.048	7.4[illegible]	8.375	9.520		
	9	#39	7.049	7.485	8.210	9.556	10.172	
	10	8/13/70	7.048	7.424	8.[illegible]	9.5[illegible]		
05	11		7.048	7.4[illegible]	8.210	[illegible]		
	12		7.048	7.435	8.[illegible]	9.[illegible]	0.387	1.256
	13	#43	7.048	7.553	8.577	9.888		
	14	9/5/70	7.048	7.552	8.576	9.8[illegible]		
07	15		7.048	7.553	8.575	9.8[illegible]		
	16		7.048	7.553	8.57[illegible]	9.88[illegible]	0.505	1.312
	17	#43	7.045	7.563	8.605	9.876		
	18	9/5/70	7.044	7.564	8.605	9.877		
05	19		7.046	7.563	8.6[illegible]	9.8[illegible]		
	20		7.045	7.563	[illegible]	[illegible]	0.518	1.272
	21	#42	7.022	8.026	9.895	11.845		
	22	11/9/70	7.021	8.02[illegible]	9.[illegible]	11.845		
05	23		7.029	[illegible]	9.895	11.845		
	24		7.020	[illegible]	9.895	11.845	1.005	1.950
	25	#47	7.029	8.257	9.971	11.974		
	26	1/19/71	7.037	8.2[illegible]	9.970	11.975		
05	27		[illegible]	8.264	9.9[illegible]	11.9[illegible]		
	28		7.037	8.266	9.971	11.974	1.228	2.003
	29	#53	7.[illegible]	8.370	10.144	12.174		
09	30	[illegible]	[illegible]	8.370	10.1[illegible]	12.172		
	31		7.038	8.374	10.1[illegible]	12.172		
	32		7.032	8.370	10.1[illegible]	12.17[illegible]	1.332	2.029
	33	#47	7.045	8.447	10.163	12.21[illegible]		
05	34	12/[illegible]/70	7.[illegible]	8.447	10.1[illegible]	12.215		
	35		[illegible]	8.[illegible]	10.1[illegible]	12.2[illegible]		
	36		[illegible]	8.[illegible]	10.1[illegible]	12.[illegible]	1.402	2.049
	37	#44	7.050	7.56[illegible]	8.[illegible]	9.970		
	38	9/4/70	7.049	7.5[illegible]	8.4[illegible]	9.970		
07	39		7.050	7.5[illegible]	8.4[illegible]	9.970		
	40		7.050	7.5[illegible]	8.5[illegible]	9.9[illegible]	0.514	1.35[illegible]

(8)	(9)	(10)	(11)	(12)	(13)	(14)
LENS C-B	ANT. CHAMBER	POST. CHAMBER	LENS	TOTAL AXIAL LENGTH		
1.813	1.8875	6.7305	7.1986	18.8146	ok	
0.937	1.4551	4.2779	3.7178	9.9448	✓	
0.875	1.1430	4.6860	3.4778	9.6517	✓	
1.023	1.2849	4.6909	4.0591	10.8381	✓	
1.042	1.1326	4.7451	3.7303	10.8127	✓	
1.860	3.7496	7.2753	7.3801	12.1340	✓	
1.705	4.5815	7.4780	6.7651	12.2196	✓	
1.774	4.9696	7.5700	7.0389	12.5395	✓	
1.717	5.2307	7.6466	6.2127	12.6820	✓	
1.047	1.8177	5.0703	4.0537	11.425	✓	

	Initials	Date
Prepared By		
Approved By		

BURROUGHS CORPORATION TODD DIVISION — THE Hadley LINE Form G580 REPRODUCIBLE

		(1) Cat # & Date	(2) Ant. Corner A	(3) Ant Lens B	(4) Post Lens C	(5) Chord D	(6) Ant. Chamber B-A	(7) Post. Chamber D-C
	1	#44	7.043	7.53[illegible]	8.56[illegible]	9.912		
	2	9/5/70	7.045	7.530	8.570	9.910		
OS	3		7.044	7.530	8.569	9.911		
	4		7.044	7.530	8.569	9.9[illegible]	0.486	1.342
	5	#44	7.044	7.767	8.947	10.275		
	6	9/22/70	7.045	7.767	8.946	10.275		
OD	7		7.043	7.767	8.947	10.275	0.724	1.328
	8		7.044	7.767	8.947	10.275		
	9	#44	7.051	7.727	8.859	10.244		
	10	9/2/70	7.049	7.737	8.859	10.245		
OS	11		7.049	7.737	8.859	10.24[illegible]		
	12		7.049	7.737	8.859	10.245	0.688	[illegible]
	13	#44	7.045	8.281	10.105	12.056		
	14	11/4/70	7.045	8.282	10.107	12.055		
OD	15		7.045	8.282	10.106	12.056		
	16		7.045	8.281	10.106	12.056	1.236	1.950
	17	#44	7.036	8.265	10.053	12.054		
	18	11/9/70	7.036	8.265	10.054	12.054		
OS	19		7.036	8.265	10.055	12.054		
	20		7.036	8.265	10.054	12.054	1.229	2.0[illegible]
	21	#44	7.042	8.238	10.054	12.053		
	22	11/9/70	7.041	8.236	10.05[illegible]	12.05[illegible]		
OD	23		7.042	8.237	[illegible]	12.[illegible]		
	24		7.042	8.237	10.[illegible]	12.[illegible]	1.195	1.9[illegible]
	25	#44	7.047	8.420	10.197	12.248		
	26	[illegible]2/70	7.047	8.420	10.195	12.248		
OS	27		7.047	8.420	10.19[illegible]	12.247		
	28		7.047	8.420	10.[illegible]	12.247	1.373	2.052
	29	#44	7.050	8.[illegible]	10.254	12.232		
	30	12/7/70	7.049	8.381	10.257	12.232		
OS	31		7.049	8.380	10.255	12.232		
	32		7.049	8.380	10.254	12.232	1.331	1.976
	33	[illegible]	7.035	8.135	9.[illegible]	11.222		
	34		7.035	8.13[illegible]	9.661	11.220		
OD	35	1/10/70	7.035	8.137	9.661	11.221		
	36		7.035	8.1[illegible]	9.661	11.221	1.101	1.560
	37	[illegible]	7.052	8.[illegible]	9.835	11.418		
	38	[illegible]	7.052	8.338	9.835	11.[illegible]		
OS	39		7.057	8.33[illegible]	9.834	11.[illegible]		
	40		7.057	8.332	9.835	11.[illegible]	1.284	1.5[illegible]

(8)	(9)	(10)	(11)	(12)	(13)	(14)
LENS C→B	ANT. CHAMBER	POST CHAMBER	LENS	TOTAL AXIAL LEN		
1.0.39	1.8132	5.0067	4.1225	1.9476	✓	
1.180	2.7612	4.9546	4.6820	1.2357	✓	
1.122	7.5669	5.126	4.4519	1.7178	✓	
1.825	4.6114	7.2153	7.2412	1.9127	✓	
1.784	4.5853	7.1618	7.0984	1.31455	✓	
1.847	4.4584	7.3424	7.3225	1.91293	✓	
1.776	5.1225	7.6552	7.0462	1.92251	✓	
1.276	4.9658	7.3723	7.4436	1.9734	✓	
1.525	4.1077	5.2202	6.0572	1.59722	OK	
1.497	4.7793	5.9060	5.9398	1.66257		

	Initials	Date
Prepared By		
Approved By		

		(1) Cat # & Date	(2) Ant. Cornea A	(3) Ant. Lens B	(4) Post. Lens C	(5) Choroid D	(6) Ant. Chamber B-A	(7) Post Chamber D-C
OD	1	T-2	7.031	7.894	9.267	10.733		
	2	2/4/70	7.030	7.895	9.267	10.772		
	3		7.031	7.895	9.267	10.731		
	4		7.031	7.895	9.267	10.733	0.864	1.466
OS	5	T-2	7.054	7.901	9.267	10.777		
	6		7.057	7.901	9.267	10.777		
	7	8/14/70	7.055	7.901	9.267	10.777		
	8		7.055	7.901	9.267	10.777	0.846	1.510
OD	9	T-2	7.040	8.077	9.429	10.994		
	10	9/14/70	7.040	8.076	9.428	10.992		
	11		7.040	8.077	9.429	10.993		
	12		7.040	8.077	9.429	10.993	1.037	1.5[illegible]
OS	13	T/2	7.037	8.507	10.473	12.445		
	14	9/14/70	7.036	8.5[illegible]	10.472	12.446		
	15		7.037	8.509	10.473	12.447		
	16		7.037	8.509	10.473	12.446	1.472	1.973
C	17	T-2	7.061	8.025	9.619	11.680		
	18	10/7/70	7.061	8.028	9.621	11.678		
OD	19		7.061	8.028	9.620	11.678		
	20		7.061	8.027	9.620	11.679	0.966	.20[illegible]
OS	21	T-2	7.035	8.318	10.244	12.384		
	22	9/7/70	7.036	8.317	10.243	12.383		
	23		7.037	8.317	10.243	12.383		
	24		7.037	8.317	10.244	12.383	1.280	2.13[illegible]
OD	25		7.056	7.503	8.508	9.799		
	26	#37	7.057	7.501	8.507	9.798		
	27	8/25/70	7.057	7.501	8.508	9.799		
	28		7.057	7.502	8.508	9.799	0.445	1.291
OS	29	#34	7.032	7.590	8.648	9.964		
	30	[illegible]	7.032	7.589	8.649	9.965		
	31		7.032	7.5[illegible]	8.647	9.966		
	32		7.032	7.5[illegible]	8.648	9.965	0.557	1.317
	33	Glass	7.000	9.725	12.471			
	34	Cube	7.001	9.726	12.471			
	35	10/13/70	7.002	9.726	12.470			
	36		7.001	9.725	12.470	2.725		
	37	Glass	7.000	9.707	12.458			1.4[illegible]
	38		6.999	9.706	12.459			1.[illegible]
	39	Cube	7.000	9.707	12.459			[illegible]
	40	10/19/70	7.000	9.707	12.458	2.707		[illegible]
					Dr[illegible]			

(8)	(9)	(10)	(11)	(12)	(13)	(14)
LENS	ANT. CHAMBER	POST CHAMBER	LENS	TOTAL AXIAL LENGTH		
C - B						
1.372	3.2235	5.4695	5.4438	1 4.1368	✓	
1.366	3.1563	5.6337	5.4200	1 4.2100	—	
1.352	3.8689	5.8351	5.3645	15.0685		
1.765	5.49.9	7.3611	7.7928	20.6455		
1.593	7.6040	7.6819	6.3077	7.6 [illegible]		
1.927	4.7756	7.9004	7.6430	20.4620		
1.006	1.6603	4.8166	3.9946	10.4685	—	
1.057	2.0781	4.9136	4.2019	1 1.1936	✓	

1/27/71 - GLASS CUBE
9.80?
9.8?
9.807
9.807

?.558 [illegible]

27.07 standard

A P P E N D I X   II

KERATOMETRY DATA (raw data)

The following are copies of the recording sheets used in collecting data from the K readings of the subjects. Values found on the forms have been converted from diopters on the power wheel to radius in millimeters used by use of the conversion tables located at the front of this section. The readings for both examiners were averaged both horizontally and vertically to obtain one value for each meridian. For a total radius value of an eye the horizontal and vertical values were averaged. Results of these calculations are given at the last of this appendix.

JAN 0 1971

CONVEX RADIUS vs POWER READING ON B & L KERATOMETER

(NO ACCESSORY LENS IN PLACE)

$r_{mm} = \frac{\Delta n}{P} = \frac{0.3375}{P} \times 1000$

35.0000 = P_D	36.7500 =	38.5000 =	40.2500 =	42.0000 =
9.6428 = r_{mm}	9.1836 =	8.7662 =	8.3850 =	8.0357 =
35.1250 =	36.8750 =	38.6250 =	40.3750 =	42.1250 =
9.6085 =	9.1525 =	8.7378 =	8.3591 =	8.0118 =
35.2500 =	37.0000 =	38.7500 =	40.5000 =	42.2500 =
9.5744 =	9.1216 =	8.7096 =	8.3333 =	7.9881 =
35.3750 =	37.1250 =	38.8750 =	40.6250 =	42.3750 =
9.5406 =	9.0909 =	8.6816 =	8.3076 =	7.9646 =
35.5000 =	37.2500 =	39.0000 =	40.7500 =	42.5000 =
9.5070 =	9.0604 =	8.6538 =	8.2822 =	7.9411 =
35.6250 =	37.3750 =	39.1250 =	40.8750 =	42.6250 =
9.4736 =	9.0301 =	8.6261 =	8.2568 =	7.9178 =
35.7500 =	37.5000 =	39.2500 =	41.0000 =	42.7500 =
9.4405 =	9.0000 =	8.5987 =	8.2317 =	7.8947 =
35.8750 =	37.6250 =	39.3750 =	41.1250 =	42.8750 =
9.4076 =	8.9700 =	8.5714 =	8.2066 =	7.8717 =
36.0000 =	37.7500 =	39.5000 =	41.2500 =	43.0000 =
9.3750 =	8.9403 =	8.5443 =	8.1818 =	7.8488 =
36.1250 =	37.8750 =	39.6250 =	41.3750 =	43.1250 =
9.3425 =	8.9108 =	8.5173 =	8.1570 =	7.8260 =
36.2500 =	38.0000 =	39.7500 =	41.5000 =	43.2500 =
9.3103 =	8.8815 =	8.4905 =	8.1325 =	7.8034 =
36.3750 =	38.1250 =	39.8750 =	41.6250 =	43.3750 =
9.2783 =	8.8524 =	8.4639 =	8.1081 =	7.7809 =
36.5000 =	38.2500 =	40.0000 =	41.7500 =	43.5000 =
9.2465 =	8.8235 =	8.4375 =	8.0838 =	7.7586 =
36.6250 =	38.3750 =	40.1250 =	41.8750 =	43.6250 =
9.2150 =	8.7947 =	8.4112 =	8.0597 =	7.7363 =

JAN 6 1971

CONVEX RADIUS vs POWER READING ON B & L KERATOMETER

(NO ACCESSORY LENS IN PLACE)

43.7500 = 7.7142 =	45.5000 = 7.4175 =	47.2500 = 7.1428 =	49.0000 = 6.8877 =	50.7500 = 6.6502 =	52.5000 = 6.4285 =
43.8750 = 7.6923 =	45.6250 = 7.3972 =	47.3750 = 7.1240 =	49.1250 = 6.8702 =	50.8750 = 6.6339 =	52.6250 = 6.4133 =
44.0000 = 7.6704 =	45.7500 = 7.3770 =	47.5000 = 7.1052 =	49.2500 = 6.8527 =	51.0000 = 6.6176 =	52.7500 = 6.3981 =
44.1250 = 7.6487 =	45.8750 = 7.3569 =	47.6250 = 7.0866 =	49.3750 = 6.8354 =	51.1250 = 6.6014 =	52.8750 = 6.3829 =
44.2500 = 7.6271 =	46.0000 = 7.3369 =	47.7500 = 7.0680 =	49.5000 = 6.8181 =	51.2500 = 6.5853 =	53.0000 = 6.3679 =
44.3750 = 7.6056 =	46.1250 = 7.3170 =	47.8750 = 7.0496 =	49.6250 = 6.8010 =	51.3750 = 6.5693 =	53.1250 = 6.3529 =
44.5000 = 7.5842 =	46.2500 = 7.2972 =	48.0000 = 7.0312 =	49.7500 = 6.7839 =	51.5000 = 6.5533 =	
44.6250 = 7.5630 =	46.3750 = 7.2776 =	48.1250 = 7.0129 =	49.8750 = 6.7669 =	51.6250 = 6.5375 =	
44.7500 = 7.5418 =	46.5000 = 7.2580 =	48.2500 = 6.9948 =	50.0000 = 6.7500 =	51.7500 = 6.5217 =	
44.8750 = 7.5208 =	46.6250 = 7.2386 =	48.3750 = 6.9767 =	50.1250 = 6.7331 =	51.8750 = 6.5060 =	
45.0000 = 7.5000 =	46.7500 = 7.2192 =	48.5000 = 6.9587 =	50.2500 = 6.7164 =	52.0000 = 6.4903 =	
45.1250 = 7.4792 =	46.8750 = 7.2000 =	48.6250 = 6.9408 =	50.3750 = 6.6997 =	52.1250 = 6.4748 =	
45.2500 = 7.4585 =	47.0000 = 7.1808 =	48.7500 = 6.9230 =	50.5000 = 6.6831 =	52.2500 = 6.4593 =	
45.3750 = 7.4380 =	47.1250 = 7.1618 =	48.8750 = 6.9053 =	50.6250 = 6.6666 =	52.3750 = 6.4439 =	

1

B & L KERATOMETER -- CONVEX RADIUS vs SCALE RDG. WITH
+ 2.75 D ACCESSORY LENS

37.000000 =	6.563595 = mm
37.125000 =	6.544713 =
37.250000 =	6.525831 =
37.375000 =	6.506949 =
37.500000 =	6.488067 =
37.625000 =	6.469185 =
37.750000 =	6.450303 =
37.875000 =	6.431421 =
38.000000 =	6.412539 =
38.125000 =	6.393657 =
38.250000 =	6.374775 =
38.375000 =	6.355893 =
38.500000 = x_2	6.318601 = y_2
38.625000 =	6.294389 =
38.750000 =	6.270737 =
38.875000 =	6.246805 =
39.000000 =	6.222873 =
39.125000 =	6.198941 =
39.250000 =	6.175009 =
39.375000 =	6.151077 =
39.500000 =	6.127145 =
39.625000 =	6.103213 =
39.750000 =	6.079281 =
39.875000 =	6.055349 =
40.000000 =	6.031417 =
40.125000 =	6.007485 =
40.250000 =	5.983553 =
40.375000 =	5.959621 =
40.500000 = x_3	5.953853 = y_3
40.625000 =	5.938173 =
40.750000 =	5.922493 =
40.875000 =	5.906813 =
41.000000 =	5.891133 =
41.125000 =	5.875453 =
41.250000 =	5.859773 =
41.375000 =	5.844093 =
41.500000 =	5.828413 =
41.625000 =	5.812733 =
41.750000 =	5.797053 =
41.875000 =	5.781373 =
42.000000 =	5.765693 =
42.125000 =	5.750013 =
42.250000 =	5.734333 =
42.375000 =	5.718653 =
42.500000 =	5.702973 =
42.625000 =	5.687293 =
42.750000 =	5.671613 =
42.875000 =	5.655933 =
43.000000 =	5.640253 =
43.125000 =	5.624573 =
43.250000 =	5.608893 =
43.375000 =	5.593213 =
43.500000 =	5.577533 =
43.625000 =	5.561853 =
43.750000 =	5.546173 =
43.875000 =	5.530493 =
44.000000 =	5.514813 =
44.125000 =	5.499133 =
44.250000 =	5.483453 =
44.375000 =	5.467773 =
44.500000 =	5.452093 =
44.625000 =	5.436413 =
44.750000 =	5.420733 =
44.875000 =	5.405053 =
45.000000 =	5.389373 =
45.125000 =	5.373693 =
45.25 F	5.358 F
45.375000 =	5.344231 =
45.500000 =	5.330462 =
45.625000 =	5.316693 =
45.750000 =	5.302924 =

B & L KEROTOMETER CALIBRATION WITH + 2.75 D ACCESSORY LENS (CONT.)

45.875000 =
5.289155 =

46.000000 =
5.275386 =

46.125000 =
5.261617 =

46.250000 =
5.247848 =

46.375000 =
5.234079 =

46.500000 =
5.220310 =

46.625000 =
5.206541 =

46.750000 =
5.192772 =

46.875000 =
5.179003 =

47.000000 =
5.165234 =

47.125000 =
5.151465 =

47.250000 =
5.137696 =

47.375000 =
5.123927 =

47.500000 =
5.110158 =

47.625000 =
5.096389 =

47.750000 =
5.082620 =

47.875000 =
5.068851 =

48.000000 =
5.055082 =

48.125000 =
5.041313 =

48.250000 =
5.027544 =

48.375000 =
5.013775 =

48.500000 =
5.000006 =

y_5 = 5. F
x_5 = 48.5 F

48.625000 =
4.987572 =

48.750000 =
4.975144 =

48.875000 =
4.962716 =

49.000000 =
4.950288 =

49.125000 =
4.937860 =

49.250000 =
4.925432 =

49.375000 =
4.913004 =

49.500000 =
4.900576 =

49.625000 =
4.888148 =

49.750000 =
4.875720 =

49.875000 =
4.863292 =

50.000000 =
4.850864 =

50.125000 =
4.838436 =

50.250000 =
4.826008 =

50.375000 =
4.813580 =

50.500000 =
4.801152 =

50.625000 =
4.788724 =

50.750000 =
4.776296 =

50.875000 =
4.763868 =

51.000000 =
4.751440 =

51.125000 =
4.739012 =

51.250000 =
4.726584 =

51.375000 =
4.714156 =

51.500000 =
4.701728 =

51.625000 =
4.689300 =

51.750000 =
4.676872 =

51.875000 =
4.664444 =

52.000000 =
4.652016 =

52.125000 =
4.639588 =

52.250000 =
4.627160 =

DERIVATION

JUL 16 1970

Rate of Change of Calculated Corneal Radius (r_{mm}) with Power Rdg. on B+L Keratometer

1. $$r_{mm} = \frac{\Delta n \times 1000}{P} = \frac{337.5}{P}$$

2. $$\frac{dr_{mm}}{dP} = -\frac{\Delta n}{P^2}$$ = rate of change of r in mm per Diopt. of indicated Power

3. $$\frac{dr_{mm}}{dP} = -\frac{\Delta n}{P^2} \div 8 = \frac{\Delta r}{\Delta P}$$ for $\Delta P = 0.125$ D

Rate of change of calculated corneal radius for $\Delta P = 0.125$D at various Pwr levels

P = 38. F
.2337 =
Δr = .0292 =

P = 41. F
.2007 =
Δr = .0250 =

P = 44. F
.1743 =
Δr = .0217 =

P = 47. F
.1527 =
Δr = .0190 =

P = 50. F
.1350 =
Δr = .0168 =

53. F
.1201 =
Δr = .0150 =

$$\Delta r = -\frac{\Delta n}{P^2} \div 8$$

First derivative [dr/dP]

[illegible] $r = 7.938$ $r = 8.73$ mm

Eyepiece at 1.25

H	V	H	V	H	V
47.25	47.25	42.50 →		38.625	38.75
47.25	47.25	42.50	42.50	38.75	38.75
47.25	47.25	42.50	42.50	38.75	38.75
47.125	47.25	42.50	42.50	38.75	38.75
47.25	47.125	42.50	42.50	38.75	38.75
47.25	47.25	42.50	42.50	38.75	38.75
47.25	47.125	--	--	38.75	38.75
47.25	47.25	N=5	—	N=7	
47.25	47.125		—		
47.25	47.25	--	—		
$\bar{x}_1$ = 47.231	47.194	42.50	42.525	38.688	38.777

Eyepiece at -1.5

Base [illegible] r = 7.144 mm

H	V	H	V	H	V
47.25	47.25	42.50	42.50	38.375	38.375
47.25	47.50	42.50	42.50	"	"
47.25	47.25	42.50	42.375	38.375	38.25
47.25	47.125	42.50	42.375	38.375	38.375
47.25	47.25	42.50	42.50	38.375	38.25
47.25	47.25	42.50	42.625	38.375	38.375
47.25	47.25	42.50	42.375	38.375	38.50
47.25	47.25	42.375	42.50	38.375	38.375
47.25	47.125	42.50	42.625	38.375	38.375
47.25	47.25	42.50	42.50	38.375	38.375
$\bar{x}_2$ = 47.219	47.244	42.463	42.488	38.356	38.363 ✓

	H	V	H	V	H	V
$\bar{x}_{1,2}$ =	47.23	47.22	42.48	42.51	38.52	38.57
T (B&L Val.) =	47.25	47.25	42.52	42.52	38.66	38.66
Diff. bet theoretical & Exper Values =	~0.003 mm	~0.004 mm	<0.02 mm error	Negl.	~0.03 mm error	<0.03 mm

Conclusion: if original B&L conversion table is used maximum error (N = 20 for 2 observers) is ±0.03 mm.

in radii

	WT	LEN		B H	B V	J H	J V
CAT #21							
BORN: 4/1/70	2480	4⁵/₀	OD	8.626	8.626	8.654	8.654
				8.654	8.626	8.626	8.599
				8.626	8.626	8.654	8.571
				25.906	25.878	25.934	25.824
			OS	8.571	8.464	8.491	8.599
				8.599	8.544	8.411	8.654
				8.544	8.599	8.484	8.464
				25.714	25.607	25.366	25.717
8/16/70	2560	4⁵/₆	OD	8.571	8.464	8.491	8.599
				8.599	8.544	8.411	8.654
				8.544	8.599	8.464	8.464
				25.714	25.607	25.364	25.717
			OS	8.626	8.626	8.654	8.654
				8.654	8.626	8.626	8.599
				8.626	8.626	8.654	8.571
9/16/70				25.906	25.878	25.934	25.824
CAT #28							
BORN: 6/27/70	270 gm	+2.75	OD	5.859	5.828	5.750	5.750
				5.812	5.797	5.655	5.671
				5.828	5.765	5.687	5.655
				17.499	17.390	17.092	17.086
			OS	5.765	5.702	5.859	5.828
				5.797	5.781	5.891	5.875
				5.765	5.750	5.828	5.812
8/5/70				17.327	17.233	17.578	17.515
CAT #30							
BORN: 6/29/70	230 gm	+2.75	OD	6.318	6.318	5.906	5.953
				6.294	6.294	5.959	5.922
				6.318	6.374	5.983	5.938
				18.930	18.986	17.845	17.813
				6.318	6.294	6.024	5.983
				6.355	6.318	6.222	6.318
				6.318	6.270	6.198	6.270
8/12/70				18.99[illegible]	18.987	18.499	18.5[illegible]

	WT	LENS		B H	B V	J H	J V
CAT #31	267gm	#2.75	OD	5.750	5.418	5.646	5.62[illegible]
BORN 7/8/70				5.734	5.734	5.655	5.655
				5.734	5.687	5.750	5.718
				17.218	17.137	17.051	[illegible]
8/11/70			OS	5.828	5.828	5.781	5.702
CAT # T_1				5.828	5.812	5.781	5.734
				5.844	5.812	5.734	5.702
				17.500	17.452	17.296	17.[illegible]
	2721gm	4/0	OD	8.231	8.206	8.181	8.181
				8.231	8.282	8.181	8.132
				8.231	8.266	8.181	8.181
				24.693	24.694	24.543	24.4[illegible]
			OS	8.357	8.231	8.256	8.256
				8.132	8.231	8.206	8.231
8/7/70				8.181	8.231	8.206	8.206
CAT # T_2				24.672	24.693	24.668	24.675
	2011gm	w/o	OD	7.377	7.356	7.417	7.356
BORN 4/11/70				7.397	7.377	7.417	7.377
				7.377	7.377	7.377	7.377
				22.131	22.116	22.211	22.110
			OS	7.417	7.500	7.417	7.458
				7.377	7.458	7.417	7.458
				7.417	7.458	7.377	7.477
8/4/70				22.211	22.416	22.231	22.395
	2430gm	w/o	OD	7.848	7.736	7.826	7.803
				7.736	7.736	7.848	7.826
				7.736	7.736	7.893	7.826
				23.320	23.208	23.477	23.455
			OS	7.848	7.803	7.826	7.894
				7.826	7.826	7.848	7.826
9/16/70				7.826	7.803	7.826	7.826
				23.500	23.482	23.500	23.5[illegible]
	2555gm	4/0	OD	7.917	7.941	7.871	7.874
				7.941	7.941	7.826	7.848
				7.941	7.964	7.826	7.803
				23.799	23.846	23.523	[illegible]
			OS	7.917	7.917	7.848	7.848
				7.941	7.941	7.848	7.849
				7.826	7.917	7.803	7.822
				23.[illegible]	23.[illegible]	23.4[illegible]	23.5[illegible]

10/ /[illegible]

CAT # 38

BORN · 7/23/70

Date	WT	LENS		B H	B V	J H	J V
	211gm	+275					
	543gm	+205	OD	6.563	6.563	6.544	6.544
			OD	6.563	6.563	6.525	6.525
			OD	6.544	6.525	6.525	6.563
				19.670	19.651	19.594	19.632
			OS	6.563	6.544	6.563	6.544
			OS	6.544	6.563	6.563	6.525
9/25/70			OS	6.544	6.563	6.544	6.544
				19.651	19.670	19.670	19.613
	603gm	+/0	OD	7.161	7.161	7.142	7.161
			OD	7.180	7.142	7.161	7.161
			OD	7.142	7.049	7.142	7.142
				21.483	21.352	21.445	21.464
			OS	7.161	7.105	7.124	7.142
			OS	7.180	7.124	7.142	7.142
			OS	7.161	7.142	7.161	7.142
10/16/70				21.502	21.371	21.427	21.426
	670gm	+/0	OD	7.105	7.105	7.142	7.031
			OD	7.086	7.105	7.161	7.049
			OD	7.105	7.124	7.105	7.031
				21.296	21.334	21.408	21.111
			OS	7.049	7.031	7.012	7.012
11/9/70			OS	7.049	7.047	7.012	7.031
			OS	7.031	7.031	7.031	7.031
				21.129	21.111	21.055	21.074
	716gm	+/0	OD	7.258	7.219	7.258	7.219
			OD	7.258	7.277	7.238	7.300
			OD	7.277	7.277	7.277	7.219
				21.773	21.773	21.773	21.658
			OS	7.258	7.219	7.219	7.258
			OS	7.258	7.200	7.180	7.238
			OS	7.277	7.258	7.180	7.200
11/27/70				21.793	21.677	21.579	21.696

CAL # 38

		B		I	
		4	V	4	V
12-18-70	WT	7.417	7.356	7.417	7.260
[illegible] 70	843.093	7.397	7.333	7.417	7.260
		7.377	7.333	7.277	7.336
		22.210	22.022	22.111	21.[illegible]36
		7.377	7.479	7.417	7.458
	05	7.417	7.458	7.417	7.458
		7.417	7.458	7.417	7.475
		22.2[illegible]	22.375	22.251	22.3[illegible]

12/18/70

CAT # 37

Date	WT	LENS	Eye	B H	B V	J H	J V
BORN: 7/23/70	193gm	+2.75	OD	5.192	[illegible]	5.206	5.123
				5.179	5.096	5.179	5.096
				5.220	5.137	5.220	5.110
				[illegible]	15.320	15.605	15.329
			OS	5.192	5.123	5.192	5.110
				5.192	5.065	5.220	5.110
				5.179	5.110	5.220	5.137
				15.563	15.301	15.632	[illegible]
8/4/70	320gm	+2.75	OS	5.514	5.530	5.530	5.546
				5.530	5.514	5.514	5.530
				5.597	5.514	5.530	5.530
				16.621	16.558	16.574	16.606
			OD WAS SUTURED				
8/25/70	610gm	+2.75	OS	6.563	6.525	6.525	6.563
				6.544	6.506	6.506	6.544
				6.525	6.525	6.525	6.506
				19.632	19.556	19.556	[illegible]
9/25/70	682gm	w/o	OS	7.049	7.068	7.031	7.047
				7.068	7.049	7.049	[illegible]
				7.049	7.086	7.068	[illegible]
				21.166	21.222	21.148	[illegible]
10/16/70	805gm	w/o	OS	7.142	7.142	7.124	7.142
				7.142	7.142	7.142	7.142
				7.161	7.142	7.105	[illegible]
				21.445	21.426	21.371	[illegible]
11/9/70	842gm	w/o	OS	7.336	7.258	7.258	7.336
				7.336	7.297	7.297	7.336
				7.317	7.317	7.277	7.336
				21.989	21.872	[illegible]	22.00
11/27/70	1071gm	w/o		7.500	7.458	7.438	7.500
				7.500	7.417	7.458	[illegible]
				7.500	7.417	7.438	[illegible]
				22.500	22.292	22.334	[illegible]
12/18/70							

CAT #36

Date	WT	LENS		B H	B V	S H	S V
BORN 7/23/70	280gm	+2.25	OD	5,750	5,765		
				5,734	5,750		
				5,734	5,734		
			Σ	17,218	17,249		
			OS	5,687	5,671		
				5,671	5,655		
				5,671	5,702		
			Σ	17,029	17,028		
8/13/70	410gm	+2.75	OD	5,702	5,687	5,734	5,640
				5,687	5,671	5,718	5,640
				5,702	5,671	5,734	5,718
				17,091	17,029	17,186	16,998
			OS	5,514	5,514	5,640	5,640
				5,546	5,577	5,577	5,514
				5,597	5,577	5,655	5,655
				16,637	16,668	16,872	16,809
8/25/70	750gm	w/o	OD	6.553	6.553	6,650	6.569
				6.553	6.553	6.553	6.553
				6.553	6.569	6.569	6.553
				19.659	19.675	19.772	19.675
			OS	6.553	6.569	6.553	6.569
				6.553	6.569	6.506	6.619
				6.553	6.569	6.553	6.601
				19.659	19.707	19.612	19.787
9/25/70	872gm	w/o	OD	7.105	7.105	7.086	7.049
				7.142	7.124	7.105	7.068
				7.142	7.105	7.086	7.049
				21.389	21.334	21.277	21.166
			OS	7.219	7.219	7.161	7.180
				7.200	7.219	7.180	7.161
				7.219	7.219	7.200	7.180
				21.638	21.657	21.541	21.521
10/16/70	967gm	w/o	OD	7.238	7.219	7.297	7.258
				7.219	7.238	7.238	7.200
				7.219	7.219	7.238	7.200
				21.676	21.676	21.773	21.658
			OS	7.258	7.258	7.124	7.219
				7.258	7.258	7.238	7.219
				7.219	7.219	7.238	7.219
				21.935	21.735	21.600	21.657
11/9/70							

CAT #3 C

	WT	B H	B V	J H	J V
11-27-70	1076 gm	7.417	7.417	7.397	7.417
W/O LENS	OD	7.356	7.377	7.377	7.500
		7.417	7.417	7.377	7.438
		22.190	22.231	22.191	22.355
		7.417	7.500	7.317	7.397
	OS	7.417	7.477	7.438	7.417
		7.417	7.417	7.458	7.417
		23.364	22.396	22.213	22.231
12-18-70	1332 gm	7.758	7.758	7.803	7.780
W/O LENS	OD	7.803	7.803	7.758	7.780
		7.803	7.758	7.780	7.803
		23.364	23.319	23.341	23.365
		7.894	7.848	7.803	7.736
		7.871	7.826	7.803	7.758
	OS	7.848	7.803	7.826	7.780
		23.613	23.477	23.432	23.274

11/27/70

12/18/70

Cat #34

Born: 7/17/70

Date	WT	LEN		B H	B V	J H	J V
7/17/70	182gm	+2.95	OD	5.302	5.330	5.302	5.247
				5.316	5.330	5.261	5.295
				5.295	5.302	5.302	5.3[illegible]2
				15.913	15.962	15.865	15.[illegible]
			OS	5.295	5.295	5.358	5.249
				5.302	5.289	5.295	5.261
				5.316	5.287	5.302	5.247
				15.893	15.863	15.935	15.[illegible]
8/6/70	484gm	+2.95	OD	6.127	6.009	6.127	6.105
				6.099	6.099	6.103	6.127
				6.099	6.127	6.127	6.103
				18.[illegible]	18.213	18.357	18.405
9/18/70	500gm	+2.95	OD	6.469	6.469	6.450	6.467
				6.469	6.469	6.450	6.488
				6.469	6.488	6.469	6.488
				19.407	19.426	19.369	19.442
10/9/70	571gm	w/o	OD	6.617	6.650	6.617	6.619
				6.601	6.569	6.601	6.619
				6.601	6.585	6.617	6.617
				19.819	19.804	19.835	19.857
10/30/70	643gm	w/o	OD	6.994	7.012	6.905	6.905
				7.068	7.049	6.940	6.994
				7.049	7.049	6.940	6.905
				21.111	21.110	20.785	20.854
11/9/70	625gm	w/o	OD	6.923	6.958	6.905	6.887
				6.923	6.923	6.887	6.887
				6.905	6.887	6.887	6.887
				20.751	20.768	20.679	20.661
11/19/70	897gm	w/o	OD	7.086	7.068	7.068	7.068
				7.068	7.049	7.105	7.105
				7.068	7.068	7.068	7.105
				21.[illegible]	21.185	21.241	21.278
12/11/70							

CAT #32

BORN: 7/8/70

	WT	LENS		B H	B V	J H	J V
	217 gm	+2.95		5.514	5.514		
			OD	5.546	5.546		
				5.546	5.546		
				16.638	[illegible]		
				5.530	5.561		
			OS	5.530	5.514		
				5.530	5.514		
				16.590	[illegible]		
8/13/70							
	340 gm	+2.95		5.234	5.206	5.247	5.192
			OD	5.234	5.220	5.220	5.192
				5.234	5.220	5.247	5.220
				15.702	15.646	15.714	15.[illegible]
				5.261	5.275	5.220	5.220
			OS	5.247	5.275	5.247	5.220
				5.261	5.247	5.247	5.261
9/14/70				15.769	15.797	15.714	15.701
	475 gm	+2.95		6.506	6.488	6.469	6.506
			OD	6.506	6.488	6.488	6.488
				6.506	6.488	6.488	6.488
				19.518	19.464	19.445	19.[illegible]
				6.525	6.544	6.506	6.546
			OS	6.525	6.563	6.525	6.506
				6.525	6.525	6.525	6.525
10/2/70				19.575	19.632	19.556	19.537
	531 gm	4/0		6.585	6.585	6.553	6.569
			OD	6.569	6.553	6.553	6.585
				6.553	6.553	6.553	6.553
				19.707	19.691	19.659	19.707
				6.553	6.569	6.553	6.490
			OS	6.537	6.553	6.506	6.566
				6.553	6.553	6.521	6.553
10/23/70				19.643	19.675	19.[illegible]	19.[illegible]
	630 gm	4/0		6.716	6.683	6.818	6.852
			OD	6.733	6.683	6.[illegible]	6.783
				6.716	6.679	6.733	6.[illegible]
				20.165	20.[illegible]	20.[illegible]	20.[illegible]
				6.835	6.783	6.835	6.[illegible]
			OS	6.825	6.801	6.852	6.[illegible]
				6.835	6.783	6.852	6.[illegible]
11/19/70				20.546	20.367	20.537	20.[illegible]

CAT #39

BORN
7/26/70

8/6/70

WT	LENS		B H	B V	S H	S V
165	+2.75	OD	5,205	5,289	5,082	5,112
		OD	5,261	5,295	5,055	5,068
		OD	5,289	5,261	5,055	5,055
			5,[illegible]	5,325	5,172	5,23
		OS	5,137	5,151	5,096	5,096
		OS	5,199	5,199	5,068	5,110
		OS	5,123	5,137	5,096	5,137
			5,437	5,467	5,260	5,343

CAT #21	(H) O.D. (B) 25.906	(V) OD (B) 25.898	8.640 (H)
8-16-70	(H) O.D. (J) 25.934	(V) OD (J) 25.824	8.617 V
(138 DAYS)	8.640 51.840	8.617 51.702	17.257
WT 2480 gm			8.628 (A)
	(H) O.S. (B) 25.714	(V) O.S (B) 25.607	8.514 (H)
	(H) O.S. (J) 25.366	(V) O.S. (J) 25.717	8.554 (V)
	8.514 51.080	8.554 51.324	17.068
			8.534 (A)
9-16-70	(H) O.D. (B) 25.714	(V) O.D (B) 25.607	8.514 (H)
169 DAYS	(H) O.D. (J) 25.366	(V) O.D. (J) 25.717	8.514 (V)
2560 gm	8.514 51.080	8.514 51.324	8.514 (A)
			8.514 A
	(H) O.S. (B) 25.906	(V) O.S. (B) 25.898	8.640 (H)
	(H) O.S. (J) 25.934	(V) O.S. (J) 25.824	8.617 (V)
	8.640 51.840	8.617 51.702	17.257
			8.628 (A)
CAT #28	(H) O.D. (B) 17.499	(V) O.D. (B) 17.390	5.765 (H)
8-5-70	(H) O.D. (J) 17.092	(V) O.D. (J) 17.076	5.744 (V)
37 DAYS	5.765 34.591	5.744 34.466	11.509
270 gm			5.754 (A)
	(H) O.S. (B) 17.327	(V) O.S. (B) 17.233	5.817 (H)
	(H) O.S. (J) 17.578	(V) O.S. J 17.515	5.791 (V)
	5.817 34.905	5.791 34.748	11.608
			5.804 (A)
CAT # 30	(H) O.D. (B) 18.930	(V) O.D. (B) 18.986	6.129 (H)
8-12-70	(H) O.D. (J) 17.848	(V) O.D. (J) 17.813	6.133 V
44 DAYS	6.129 36.778	6133 36.799	12.262
230 gm			6.131 (A)
	(H) O.S. (B) 18.991	(V) O.S. (B) 18.882	[illegible]
	(H) O.S. (J) 18.499	(V) O.S. (J) 18.571	[illegible]
	6.248 37.490	6.242 37.453	12.490
			6.245 (A)

CAT#31	(H) O.D (B) 17.218		(V) OD (B) 17.139		5.711 (H)
8-11-70	(H) OD (J) 17.051		(V) OD (J) 16.997		5.719 (V)
34 DAYS	5.711	34.269	5.719	34.316	11.430
267 gm					5.715 (A)
	(H) OS (B) 17.500		(V) OS (B) 17.452		5.799 (H)
	(H) OS (J) 17.296		(V) OS (J) 17.138		5.765 (V)
	5.799	34.796	5.765	34.590	5.782 A
CAT#T1	(H) OD (B) 24.693		(V) OD (B) 24.694		(A) 8.206 (H)
8-7-70	(H) OD (J) 24.543		(V) OD (J) 24.494		8.198
2721 gm	8.206	49.236	8.198	49.188	16.404
					8.202 (A)
	(H) OS (B) 24.672		(V) OS (B) 24.693		8.223 (H)
	(H) OS (J) 24.668		(V) OS (J) 24.693		8.231 (V)
	8.223	49.340	8.231	49.386	16.454
					8.227 (A)
CAT#T2	(H) OD (B) 22.131		(V) OD (B) 22.110		7.390 (H)
8-4-70	(H) OD (J) 22.211		(V) OD (J) 22.110		7.370 (V)
2011 gm	7.390	44.342	7.370	44.220	14.760
					7.380 (A)
	(H) OS (B) 22.211		(V) OS (B) 22.416		7.407 (H)
	(H) OS (J) 22.231		(V) OS (J) 22.395		7.468 (V)
	7.407	44.442	7.468	44.811	14.875
					7.438 (A)
9-16-70	(H) OD (B) 23.320		(V) OD (B) 23.208		7.800 (H)
2430 gm	(H) OD (J) 23.477		(V) OD (J) 23.455		7.777 (V)
	7.800	46.797	7.777	46.663	15.577
					7.788 (A)
	(H) OS (B) 23.500		(V) OS (B) 23.432		7.833
	(H) OS (J) 23.500		(V) OS (J) 23.546		7.830 (V)
	7.833	47.000	7.830	46.978	15.663
					7.832 (A)

CAT # T2 CONT	(H) OD (B)	23.799	(V) OD (B)	23.846	7.887 (H)
10-7-70	(H) OD (J)	23.523	(V) OD (J)	23.545	7.899 (V)
2555 gm	7.887	47.322	7.899	47.391	15.786
					7.893 (A)
	(H) OS (B)	23.684	(V) OS (B)	23.775	7.864 (H)
	(H) OS (J)	23.499	(V) OS (J)	23.522	7.883 (V)
	7.864	47.183	7.883	47.297	15.747
					7.874 (A)
CAT # 39	(H) OD (B)	15.825	(V) OD (B)	15.825	5.169 (H)
8-6-70	(H) OD (J)	15.192	(V) OD (J)	15.233	5.176 (V)
11 DAYS	5.169	31.017	5.176	31.058	10.348
165 gm					5.172 (A)
	(H) OS (B)	15.439	(V) OS (B)	15.467	5.116 (H)
	(H) OS (J)	15.260	(V) OS (J)	15.343	5.135 (V)
	5.116	30.699	5.135	30.810	10.251
					5.126 (A)
CAT # 32	(H) OD (B)	16.638	(V) OD (B)	16.606	5.546 (H)
8-13-70	(H) OD (J)		(V) OD (J)		5.353 (V)
36 DAYS	5.546		5.353		10.899
217 gm					5.450 (H)
	(H) OS (B)	16.590	(V) OS (B)	16.589	5.530 (H)
	(H) OS (J)		(V) OS (J)		5.528 (V)
	5.530		5.528		11.058
					5.529 (A)
9-14-70	(H) OD (B)	15.702	(V) OD (B)	15.646	5.237 (H)
68 DAYS	(H) OD (J)	15.714	(V) OD (J)	15.604	5.208 (V)
360 gm	5.237	31.416	5.208	31.250	10.445
					5.222 (A)
	(H) OS (B)	15.769	(V) OS (B)	15.797	5.247 (H)
	(H) OS (J)	15.714	(V) OS (J)	15.701	5.249 (V)
	5.247	31.483	5.249	31.498	10.496
					5.248 (A)

CN #32
CONT

10-2-70	(H) OD (B) 19,518	(V) OD (B) 19,464	6.494 (H)
86 DAYS	(H) OD (J) 19,445	(V) OD (J) 19,482	6,491 (V)
495 gm	6.494 38.963	6.491 38.946	12,985
			6,492 (A)
	(H) OS (B) 19,575	(V) OS (B) 19,632	6.522 (H)
	(H) OS (J) 19,556	(V) OS (J) 19,537	6,528 (V)
	6.522 39.131	6.528 39.169	13,050
			6.525 (A)
10-23-70	(H) OD (B) 19,707	(V) OD (B) 19,691	6.561 (H)
107 DAYS	(H) OD (J) 19,659	(V) OD (J) 19,707	6.566 (V)
531 gm	6.561 39,366	6.566 39.398	13,127
			6.564 (A)
	(H) OS (B) 19,643	(V) OS (B) 19,675	6,537 (H)
	(H) OS (J) 19,580	(V) OS (J) 19,549	6,537 (V)
	6.537 39.223	6.537 39.224	6.537
			6,537 (A)
11-19-70	(H) OD (B) 20,165	(V) OD (B) 20,065	6,739 (H)
134 DAYS	(H) OD (J) 20,267	(V) OD (J) 20,351	6,736 (V)
630 gm	6.739 40.432	6.736 40.416	13,475
			6.738 (A)
	(H) OS (B) 20,546	(V) OS (B) 20,367	6,847 (H)
	(H) OS (J) 20,539	(V) OS (J) 20,318	6,782 (V)
	6.847 41.085	6.7820 40.685	13,629
			6.814 (A)

CAT # 34	(H) OD (B) 15.893	(V) OD (B) 15.962	5.293 (H)
8-6-70	(H) OD (J) 15.865	(V) OD (J) 15.824	5.297 (V)
20 DAYS	5.293 31.758	5.297 31.786	10.590
182 gm			5.295 (A)
	(H) OS (B) 15.893	(V) OS (B) 15.853	5.304 (H)
	(H) OS (J) 15.935	(V) OS (J) 15.755	5.268 (V)
	5.304 31.828	5.268 31.608	10.572
			5.286 (A)
9-18-70	(H) OD (B) 18.285	(V) OD (B) 18.213	6.107 (H)
63 DAYS	(H) OD (J) 18.357	(V) OD (J) 18.405	6.103 (V)
484 gm	6.107 36.642	6.103 36.618	12.210
			6.105 (A)
10-9-70	(H) OD (B) 19.407	(V) OD (B) 19.426	6.462 (H)
84 DAYS	(H) OD (J) 19.369	(V) OD (J) 19.445	6.478 (V)
500 gm	6.462 38.776	6.478 38.871	13.071
			6.470 (A)
10-30-70	(H) OD (B) 19.819	(V) 19.804 OD (B)	6.609 (H)
105 DAYS	(H) OD (J) 19.835	(V) 19.851 OD (J)	6.609 (V)
571 gm	6.609 39.654	39.655 6.609	6.609
			6.609 (A)
11-9-70	(H) OD (B) 21.111	(V) 21.110 OD (B)	6.983 (H)
115 DAYS	(H) OD (J) 20.785	(V) 20.804 OD (J)	6.986 (V)
643 gm	6.983 41.896	41.914 6.986	13.969
			6.984 (A)
11-19-70	(H) OD (B) 20.751	(V) OD (B) 20.768	6.905 (H)
125 DAYS	(H) OD (J) 20.679	(V) OD (J) 20.661	6.905 (V)
625 gm	6.905 41.430	6.905 41.429	
			6.905 (A)
12-11-70	(H) OD (B) 21.222	(V) OD (B) 21.851	7.077 (H)
147 DAYS	(H) OD (J) 21.241	(V) OD (J) 21.278	7.188 (V)
827 gm	7.077 42.463	7.188 43.129	14.265
			7.132 (A)

CAT#36

8-13-70 21 DAYS 280gm	(H) OD(B) 17.218 (H) OD(J) 5.738	(V) OD(B) 17.249 (V) OD(J) 5.749	5.738(H) 5.749 (V) 11.487 5.744 (A)
	(H) OS(B) 17.029 (H) OS(J) 5.675	(V) OS(B) 17.028 (V) OS(J) 5.675	5.675 (H) 5.675 (V) 5.675 (A)
8-25-70 33 DAYS 410gm	(H) OD(B) 17.091 (H) OD(J) 17.186 5.712 34.277	(V) OD(B) 17.029 (V) OD(J) 16.998 5.671 34.027	5.712(H) 5.671(V) 11.383 5.692(A)
	(H) OS(B) 16.637 (H) OS(J) 16.872 5.584 33.509	(V) OS(B) 16.668 (V) OS(J) 16.809 5.579 33.477	5.584(H) 5.579 (V) 11.163 5.582(A)
9-25-70 64 DAYS 750gm	(H) OD(B) 19.659 (H) OD(J) 19.772 6.572 39.431	(V) OD(B) 19.675 (V) OD(J) 19.675 6.558 39.350	6.572(H) 6.558 (V) 13.130 6.565 (A)
	(H) OS(B) 19.659 (H) OS(J) 19.612 6.545 39.271	(V) OS(B) 19.707 (V) OS(J) 19.787 6.580 39.484	6.545 (H) 6.580 (V) 13.125 6.562 (A)
10-16-70 85 DAYS 822gm	(H) OD(B) 21.389 (H) OD(J) 21.277 7.111 42.666	(V) OD(B) 21.334 (V) OD(J) 21.166 7.083 42.500	7.111(H) 7.083(V) 14.194 7.097(A)
	(H) OS(B) 21.638 (H) OS(J) 21.541 7.196 43.179	(V) OS(B) 21.657 (V) OS(J) 21.521 7.196 43.178	7.196(H) 7.196(V) 7.196(A)

CAT #36
CONT.

11-9-70	(H) OD (B) 21.676	(V) OD (B) 21.676	7.241 (H)
109 DAYS	(H) OD (J) 21.773	(V) OD (J) 21.658	7.222 (V)
967 gm	7.241 43.449	7.222 43.334	14.463
			7.232 (A)
	(H) OS (B) 21.735	(V) OS (B) 21.735	7.222 (H)
	(H) OS (J) 21.600	(V) OS (J) 21.657	7.232 (V)
	7.222 43.335	7.232 43.392	14.454
			7.227 (A)
11-27-70	(H) OD (B) 22.190	(V) OD (B) 22.231	7.397 (H)
127	(H) OD (J) 22.191	(V) OD (J) 22.355	7.431 (V)
1076 gm	~~7.232~~ 44.381	7.431 44.586	14.828
	7.397		7.414 (A)
	(H) OS (B) 23.364	(V) OS (B) 22.396	7.596 (H)
	(H) OS (J) 22.213	(V) OS (J) 22.231	7.438 (V)
	7.596 45.577	7.438 44.627	15.034
			7.517 (A)
12-18-70	(H) OD (B) 23.364	(V) OD (B) 23.319	7.784 (H)
148	(H) OD (J) 23.341	(V) OD (J) 23.363	7.780 (V)
1332 gm	7.784 46.705	7.780 46.682	15.564
			7.782 (A)
	(H) OS (B) 23.613	(V) OS (B) 23.477	7.841 (H)
	(H) OS (J) 23.432	(V) OS (J) 23.274	7.792 (V)
	7.841 47.045	7.792 46.751	15.633
			7.817 (A)
CAT # 37	(H) OD (B) 15.591	(V) OD (B) 15.370	5.199 (H)
8-4-70	(H) OD (J) 15.605	(V) OD (J) 15.329	5.116 (V)
12 DAYS	5.199 31.196	5.116 30.699	10.315
193 gm			5.157 (A)
	(H) OS (B) 15.563	(V) OS (B) 15.301	5.199 (H)
	(H) OS (J) 15.632	(V) OS (J) 15.357	5.109 (V)
	5.199 31.195	5.109 30.658	10.308
			5.154 (A)

CAT #37 CONT.			
8-25-70	(H) OS (B) 16,621	(V) OS (B) 16,558	5,532 (H)
33 DAYS	(H) OS (S) 16,574	(V) OS (S) 16,606	5,527 (V)
320 gm	5.532 33,195	5.527 33,164	11,059
			5,530 (A)
9-25-70	(H) OS (B) 19,632	(V) OS (B) 19,556	6,531 (H)
64 DAYS	(H) OS (S) 19,556	(V) OS (S) 19,575	6,522 (V)
610 gm	6.531 39,188	6.522 39,131	13,053
			6,526 (A)
10-16-70	(H) OS (B) 21,166	(V) OS (B) 21,222	7,052 (H)
85 DAYS	(H) OS (S) 21,148	(V) OS (S) 21,185	7,068 (V)
687 gm	7.052 42,314	7,068 42.407	14,120
			7,060 (A)
11-9-70	(H) OS (B) 21,445	(V) OS (B) 21,426	7,136 (H)
109 DAYS	(H) OS (S) 21,371	(V) OS (S) 21,408	7,139 (V)
805 gm	7.136 42,816	7.139 42,834	14.275
			7,138 (A)
11-27-70	(H) OS (B) 21,989	(V) OS (B) 21,872	7,307 (H)
127 DAYS	(H) OS (S) 21,852	(V) OS (S) 22,008	7,313 (V)
842 gm	7.307 43.841	7.313 43.880	14,620
			7,310 (A)
12-18-70	(H) OS (B) 22,500	(V) OS (B) 22,292	7,472 (H)
148 DAYS	(H) OS (S) 22,334	(V) OS (S) 22,417	7,451 (V)
1071 gm	7.472 44.834	7.451 44.709	14,923
			7,462 (A)
CAT # 38	(H) OD (B) 19,670	(V) OD (B) 19,651	6,544 (H)
NO BANDAGES 8-19-70	(H) OD (S) 19,594	(V) OD (S) 19,632	6,535 (V)
22 DAYS 211 gm	6.544 39,264	6.535 39.283	13,079
9-25-70			6,540 (A)
64 DAYS	(H) OS (B) 19,651	(V) OS (B) 19,670	6,553 (H)
543 gm	(H) OS (S) 19,690	(V) OS (S) 19,613	6,547 (V)
	6.553 39.321	6.547 39.283	13,100
			6,550 (A)

CAT # 38

10-16-70
85 DAYS
603 gm

(H) OD (B) 21,483
(H) OD (S) 21,445
7.155 42,928

(V) OD (B) 21,352
(V) OD (S) 21,464
7.136 42,816

7.155 (H)
7.136 (V)
14,291
7.145 (A)

(H) OS (B) 21,502
(H) OS (S) 21,427
7.155 42,929

(V) OS (B) 21,371
(V) OS (S) 21,426
7.133 42,797

7.155 (H)
7.133 (V)
14,288
7.144 (A)

11-9-70
109 DAYS
670 gm

(H) OD (B) 21,296
(H) OD (S) 21,408
7.117 42,704

(V) OD (B) 21,334
(V) OD (S) 21,111
7.074 42,445

7.117 (H)
7.074 (V)
14,191
7.095 (A)

(H) OS (B) 21,129
(H) OS (S) 21,055
7.031 42,184

(V) OS (B) 21,111
(V) OS (S) 21,074
7.031 42,185

7.031 (H)
7.031 (V)
7.031 (A)

11-27-70
127 DAYS
716 gm

(H) OD (B) 21,773
(H) OD (S) 21,773
7.258 43,546

(V) OD (B) 21,773
(V) OD (S) 21,638
7.235 43,411

7.258 (H)
7.235 (V)
14,493
7.247 (A)

(H) OS (B) 21,793
(H) OS (S) 21,579
7.229 43,372

(V) OS (B) 21,677
(V) OS (S) 21,696
7.229 43,373

7.229 (H)
7.229 (V)
7.229 (A)

12-18-70
148 DAYS
843 gm

(H) OD (B) 22,210
(H) OD (S) 22,111
7.387 44,321

(V) OD (B) 22,022
(V) OD (S) 21,736
7.293 43,758

7.387 (H)
7.293 (V)
14,680
7.340 (A)

(H) OS (B) 22,231
(H) OS (S) 22,251
7.414 44,482

(V) OS (B) 22,395
(V) OS (S) 22,395
7.465 44,790

7.414 (H)
7.465 (V)
14,879
7.439 (A)

Simple Linear Regression Analysis

*SIMLIN

This program computes linear regression coefficients, analysis of variance, and gives complete descriptions of the x and y variables.

An Example of Running the Program

Turn the teletype to ON LINE.

Type a CONTROL A (Hold down the control key and type an A.). If the computer is operating it will respond by typing a pound sign (#). You now have 20 seconds to enter your job number and user code. The computer will respond by blanking out your job and user code and then typing another pound sign.

```
(CS,A)
000000000000   (CR) †
AUGUST 20, 1970  2:45 PM TERMINAL 043
```

This program can enter some data from a data file. The header information must be entered from the teletype.

To run the program type *SIMLIN and a carriage return.

The following is an example of the program and its output:

† All information entered by the user is underlined.

708093 R6 D7

38

```
#*SIMLIN
*** SIMPLE CORRELATION AND REGRESSION  ***
PLEASE TERMINATE RESPONSES WITH CARRIAGE RETURN.
DO YOU WISH TO ENTER DATA FROM TELETYPE? YES;
N = NUMBER OF PAIRS
WHAT IS N ? 4
N=  4.0000000
CORRECT ? YES
ENTER X,Y DATA POINTS
X IS 2; ERR 2
  Y IS 3
X IS 4,  Y IS 5
X IS 6,  Y IS 7
X IS 8,  Y IS 9
DO YOU WISH TO LIST AND CHECK DATA ? NO
DO YOU WISH TO CHANGE DATA ? NO
```

```
**************************************************************************
*SIMLIN - CORRELATION AND SIMPLE LINEAR REGRESSION.          VER.3.0
OREGON STATE UNIVERSITY COMPUTER CENTER                 DATE - 08/20/70
**************************************************************************

PROBLEM IDENTIFICATION - PROBLEM.

SAMPLE SIZE =          4

SUM OF X .................                 20.00000
MEAN OF X ................                  5.00000
STANDARD DEVIATION OF X ...                 2.58199
STANDARD ERROR OF MEAN ....                 1.29099
MAXIMUM  X ...............                  8.00000
MINIMUM  X ...............                  2.00000
RANGE OF X ...............                  6.00000

SUM OF Y .................                 24.00000
MEAN OF Y ................                  6.00000
STANDARD DEVIATION OF Y ...                 2.58199
STANDARD ERROR OF MEAN ....                 1.29099
MAXIMUM  Y ...............                  9.00000
MINIMUM  Y ...............                  3.00000
RANGE OF Y ...............                  6.00000

REGRESSION LINE    Y = A + B * X

A =         1.000000     STANDARD ERROR OF A =                 0
B =         1.000000     STANDARD ERROR OF B =                 0

CORRELATION COEFFICIENT R  =  1.000000000

        ANALYSIS OF VARIANCE

SOURCE OF        DEGREES OF          SUM OF          MEAN
VARIATION         FREEDOM            SQUARES         SQUARE

 TOTAL               3              20.00000         6.6667
 REGRESSION          1              20.00000        20.0000
 ERROR               2                     0              0


END OF PROGRAM EXECUTION
DO YOU WISH FURTHER TESTS?  NO


END OF *SIMLIN EXECUTION.
```

SIMPLE LINEAR REGRESSION ANALYSIS
RADIUS OF CURVATURE Vs AGE OF THE
CAT IN DAYS FROM BIRTH

X IS 11, Y IS 5.172
X IS 34, Y IS 5.715
X IS 36, Y IS 5.450
X IS 20, Y IS 5.295
X IS 21, Y IS 5.675
X IS 33, Y IS 5.692
X IS 33, Y IS 5.530
X IS 66, Y IS 5.222
X IS 63, Y IS 6.105
X IS 64, Y IS 6.565
X IS 64, Y IS 6.526
X IS 64, Y IS 6.540
X IS 86, Y IS 6.492
X IS 84, Y IS 6.470
X IS 85, Y IS 7.097
X IS 85, Y IS 7.060
X IS 85, Y IS 7.145
X IS 107, Y IS 6.564
X IS 105, Y IS 6.609
X IS 109, Y IS 7.232
X IS 109, Y IS 7.138
X IS 109, Y IS 7.095
X IS 115, Y IS 6.984
X IS 125, Y IS 6.905
X IS 127, Y IS 7.414
X IS 127, Y IS 7.310
X IS 127, Y IS 7.247
X IS 147, Y IS 7.132
X IS 148, Y IS 7.782
X IS 148, Y IS 7.462
X IS 148, Y IS 7.340

SAMPLE SIZE = 32

SUM OF X	2699.00000
MEAN OF X	84.34375
STANDARD DEVIATION OF X ...	43.17079
STANDARD ERROR OF MEAN	7.63159
MAXIMUM X	148.00000
MINIMUM X	11.00000
RANGE OF X	137.00000
SUM OF Y	209.12200
MEAN OF Y	6.53506
STANDARD DEVIATION OF Y ...	.78884
STANDARD ERROR OF MEAN	.13945
MAXIMUM Y	7.78200
MINIMUM Y	5.15700
RANGE OF Y	2.62500

REGRESSION LINE Y = A + B * X

A =	5.135748	STANDARD ERROR OF A =	.132039
B =	.016591	STANDARD ERROR OF B =	.001396

CORRELATION COEFFICIENT R = .907949378

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE
TOTAL	31	19.29049	.6223
REGRESSION	1	[illegible]	[illegible]

SIMPLE LINEAR REGRESSION ANALYSIS
RADIUS OF CURVATURE Vs GROWTH IN
AXIAL LENGTH

X IS 15.90, Y IS 8.514
X IS 15.92, Y IS 8.628
X IS 10.44, Y IS 5.745
X IS 11.08, Y IS 5.804
X IS 15.98, Y IS 8.202
X IS 16.62, Y IS 8.227
X IS 14.14, Y IS 7.380
X IS 14.21, Y IS 7.438
X IS 17.61, Y IS 7.788
X IS 17.61, Y IS 7.832
X IS 20.65, Y IS 7.893
X IS 20.61, Y IS 7.874
X IS 9.450, Y IS 5.172
X IS 9.602, Y IS 5.126
X IS 11.60, Y IS 5.450
X IS 11.08, Y IS 5.529
X IS 13.69, Y IS 5.222
X IS 13.90, Y IS 5.248
X IS 16.62, Y IS 6.492
X IS 16.82, Y IS 6.525
X IS 16.65, Y IS 6.564
X IS 17.37, Y IS 6.537
X IS 18.22, Y IS 6.738
X IS 18.11, Y IS 6.814
X IS 10.16, Y IS 5.295
X IS 10.34, Y IS 5.286
X IS 13.04, Y IS 6.105
X IS 15.91, Y IS 6.470
X IS 17.73, Y IS 6.609
X IS 17.74, Y IS 6.984
X IS 18.40, Y IS 6.905
X IS 19.60, Y IS 7.132
X IS 10.77, Y IS 5.744
X IS 10.67, Y IS 5.675
X IS 11.20 , Y IS 5.692
X IS 11.20, Y IS 5.582
X IS 15.16, Y IS 6.565
X IS 15.27, Y IS 6.562
X IS 18.26, Y IS 7.097
X IS 17.84, Y IS 7.196
X IS 18.64, Y IS 7.232
X IS 18.30, Y IS 7.227
X IS 18.95, Y IS 7.414, X IS 19.33, Y IS 7.517
X IS 19.50, Y IS 7.782
X IS 19.68, Y IS 7.817
X IS 11.36, Y IS 5.157
X IS 11.43, Y IS 5.154
X IS 13.75, Y IS 5.530
X IS 15.80, Y IS 6.526
X IS 17.43, Y IS 7.060
X IS 17.79, Y IS 7.138
X IS 18.65, Y IS 7.310
X IS 18.95, Y IS 7.462
X IS 14.60, Y IS 6.540
X IS 14.71, Y IS 6.550
X IS 16.60, Y IS 7.145
X IS 16.19, Y IS 7.144
X IS 16.61, Y IS 7.095
X IS 17.14, Y IS 7.031
X IS 18.07, Y IS 7.247
X IS 17.87, Y IS 7.229
X IS 18.64, Y IS 7.340

```
*SIMLIN - CORRELATION AND SIMPLE LINEAR REGRESSION.          VER.3.0
OREGON STATE UNIVERSITY COMPUTER CENTER              DATE - 04/06/71
*******************************************************************

PROBLEM IDENTIFICATION - PROBLEM.      SIMPLE LINEAR REGRESSION ANALYSIS
                                       RADIUS OF CURVATURE Vs GROWTH IN
                                       AXIAL LENGTH
SAMPLE SIZE =           65

SUM OF X ..................          1005.97200
MEAN OF X .................            15.47649
STANDARD DEVIATION OF X ...             3.67469
STANDARD ERROR OF MEAN ....              .45579
MAXIMUM X .................            20.65000
MINIMUM X .................                   0
RANGE OF X ................            20.65000

SUM OF Y ..................           430.72700
MEAN OF Y .................             6.62657
STANDARD DEVIATION OF Y ...             1.24693
STANDARD ERROR OF MEAN ....              .15466
MAXIMUM Y .................             7.12800
MINIMUM Y .................                   0
RANGE OF Y ................             7.[illegible]2800

REGRESSION LINE   Y = A + B * X

A =        2.109592     STANDARD ERROR OF A =        .346751
B =         .291890     STANDARD ERROR OF B =        .021608

CORRELATION COEFFICIENT R  =    .860109400

        ANALYSIS OF VARIANCE

SOURCE OF       DEGREES OF       SUM OF        MEAN
VARIATION        FREEDOM         SQUARES       SQUARE

 TOTAL             64            99.50956       1.5548
 REGRESSION         1            73.61600      73.6160
 ERROR             63            25.89356        .4110


[illegible] REGRESSION [illegible]
DO YOU WISH FURTHER TESTS?
```

SIMPLE LINEAR REGRESSION ANALYSIS
CHANGE IN LENS THICKNESS Vs
GROWTH IN AXIAL LENGTH

1	1.5900000E 01	6.4600000E 00
2	1.5920000E 01	6.2100000E 00
3	1.0440000E 01	4.2000000E 00
4	1.1080000E 01	4.0200000E 00
5	1.5980000E 01	6.0500000E 00
6	1.6620000E 01	5.9400000E 00
7	1.4140000E 01	5.4400000E 00
8	1.4210000E 01	5.4200000E 00
9	1.7610000E 01	6.3200000E 00
10	1.7610000E 01	6.3200000E 00
11	2.0650000E 01	7.7900000E 00
12	2.0610000E 01	7.6500000E 00
13	9.4500000E 00	3.7200000E 00
14	9.6000000E 00	3.4700000E 00
15	1.1600000E 01	4.9600000E 00
16	1.1080000E 01	4.9600000E 00
17	1.3690000E 01	5.2500000E 00
18	1.3900000E 01	5.2200000E 00
19	1.6620000E 01	6.2200000E 00
20	1.6820000E 01	6.1100000E 00
21	1.6650000E 01	6.6400000E 00
22	1.7370000E 01	6.8900000E 00
23	1.8220000E 01	6.8800000E 00
24	1.8110000E 01	6.8900000E 00
25	1.0160000E 01	4.7500000E 00
26	1.0340000E 01	5.0000000E 00
27	1.3040000E 01	5.4200000E 00
28	1.5910000E 01	5.2100000E 00
29	1.7730000E 01	6.3100000E 00
30	1.7740000E 01	6.3100000E 00
31	1.8400000E 01	6.5400000E 00
32	1.9600000E 01	6.5000000E 00
33	1.0770000E 01	4.0900000E 00
34	1.0670000E 01	4.6300000E 00
35	1.1200000E 01	4.9600000E 00
36	1.1200000E 01	4.9600000E 00
37	1.5160000E 01	5.5800000E 00
38	1.5270000E 01	5.6100000E 00
39	1.8260000E 01	6.6500000E 00
40	1.7840000E 01	5.0000000E-01
41	1.8640000E 01	6.8500000E 00
42	1.8300000E 01	6.7500000E 00
43	1.8950000E 01	6.8300000E 00
44	1.9330000E 01	6.9700000E 00
45	1.9500000E 01	7.1400000E 00
46	1.9680000E 01	7.5200000E 00
47	1.1360000E 01	5.1600000E 00
48	1.1430000E 01	5.6900000E 00
49	1.3750000E 01	5.2400000E 00
50	1.5800000E 01	5.1800000E 00
51	1.7430000E 01	5.3200000E 00
52	1.7790000E 01	6.8300000E 00
53	1.8650000E 01	6.7100000E 00
54	1.8950000E 01	6.9300000E 00
55	1.1720000E 01	5.2500000E 00
56	1.1670000E 01	5.2800000E 00
57	1.4600000E 01	5.4100000E 00
58	1.4710000E 01	5.6000000E 00
59	1.6100000E 01	6.8200000E 00
60	1.6190000E 01	6.6400000E 00
61	1.6610000E 01	6.6800000E 00
62	1.7140000E 01	6.8600000E 00
63	[illegible]	[illegible]

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*************************************************************************
*SIMLIN - CORRELATION AND SIMPLE LINEAR REGRESSION.          VER.3.0
OREGON STATE UNIVERSITY COMPUTER CENTER              DATE - 04/06/71
*************************************************************************
                                        SIMPLE LINEAR REGRESSION ANALYSIS
PROBLEM IDENTIFICATION - PROBLEM.      CHANGE IN LENS THICKNESS Vs
                                        GROWTH IN AXIAL LENGTH

SAMPLE SIZE =          64

SUM OF X .................            991.41000
MEAN OF X ................             15.49078
STANDARD DEVIATION OF X ...             3.16556
STANDARD ERROR OF MEAN ....              .39570
MAXIMUM  X ...............             20.65000
MINIMUM  X ...............              9.45000
RANGE OF X ...............             11.20000

SUM OF Y .................            379.38000
MEAN OF Y ................              5.92781
STANDARD DEVIATION OF Y ...              .98307
STANDARD ERROR OF MEAN ....              .12288
MAXIMUM  Y ...............              7.79000
MINIMUM  Y ...............              3.47000
RANGE OF Y ...............              4.32000

REGRESSION LINE    Y = A + B * X

A =        1.525506     STANDARD ERROR OF A =          .251347
B =         .284189     STANDARD ERROR OF B =          .015902

CORRELATION COEFFICIENT R  =    .915113667

        ANALYSIS OF VARIANCE

SOURCE OF       DEGREES OF          SUM OF          MEAN
VARIATION        FREEDOM            SQUARES         SQUARE

 TOTAL              63              60.88449          .9664
 REGRESSION          1              50.98669        50.9867
 ERROR              62               9.89781          .1596
```

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12. Jansson, F., Op. cit., Vol 41, Pp. 343

13. Young, F.A.; Leary, G.A.; Farrer, D.N., "Ultrasound and Phakometry Measurements of the Primate Eye," American Journal of Optometry and Archives of American Academy of Optometry, June, 1966.

FOOTNOTES (cont')

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15. Ibid., Pp. 295.

16. Vakkur, G.J.; Bishop, P.O.; "The Schematic Eye in the Cat," Vision Research, Vol. 3, 1963 Pp. 365.

17. Ibid., Pp. 366, 367.

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2. Blitz, J., (1951), Ultrasound in Ophthalmology, Chp. 1, Pp. 20.

3. Jansson, F., "Determination of the Axis Length of the Eye Roentgenologically and by Ultrasound," Acta Ophthalmologica, Vol. 41, Pp. 240, 1963.

4. Jansson, F., "Measurement of Intraocular Distances by Ultrasound," Supplementum 74, Acta Ophthalmologica, Chp. 1 Pp. 13.

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